3-D-45

# INSTRUCTION MANUAL

## SERIES LX-2

## DIGITAL MULTI-FUNCTION METER

V. L. I.
Property

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

## NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

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February 1972

# V. L. I. Property

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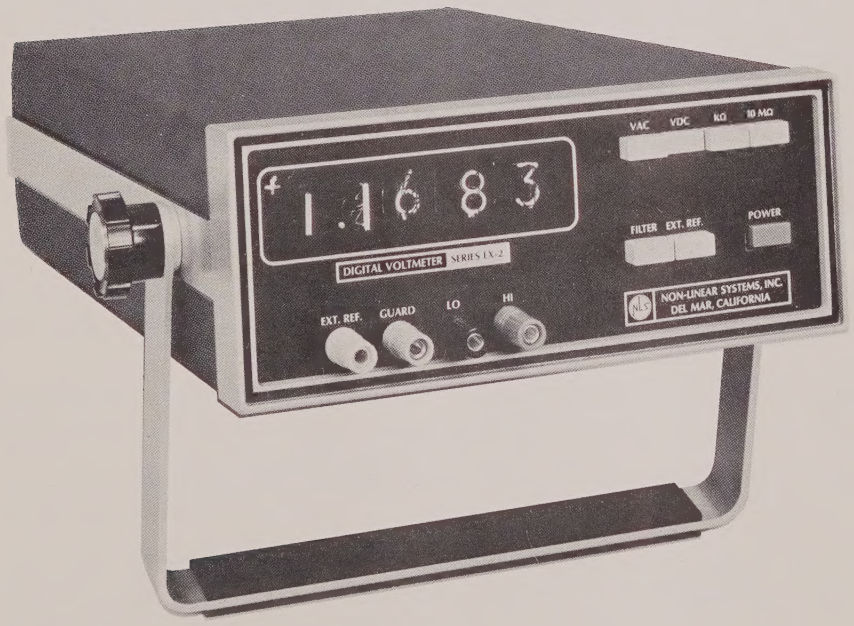


*Originator of the Digital Voltmeter*
**non-linear systems, inc.**
DEL MAR (SAN DIEGO), CALIFORNIA

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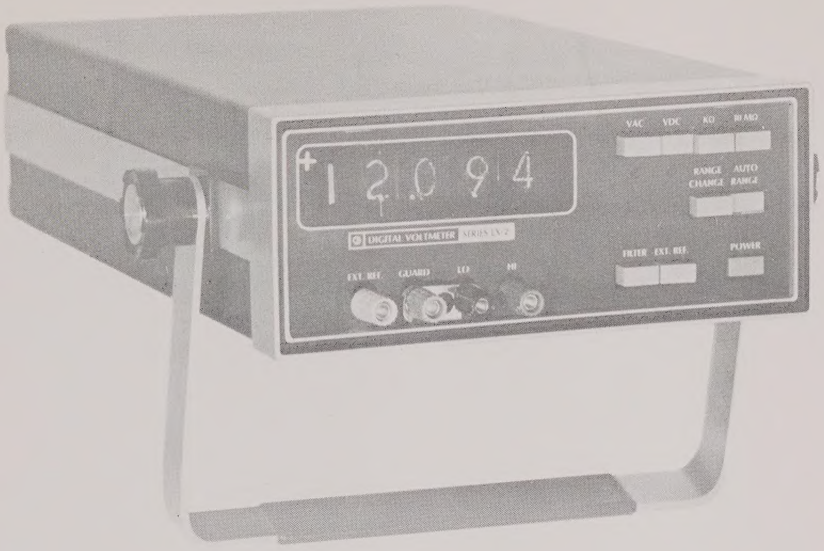


Automatic and Manual Ranging LX-2A

SUPPLEMENT I

The Model LX-2A Digital Multi-Function Meter (P/N 35-2) differs from the Series LX-2 DVM (P/N 35-1), described in this manual, in the following respects:

1. An AUTO RANGE switch and a RANGE CHANGE switch have been added to the front panel of the instrument.
   a. To utilize the auto-ranging capability of the instrument, depress the AUTO RANGE pushbutton switch.
   b. To manually select a range, release the AUTO RANGE switch; note the position of the decimal point. Press the RANGE CHANGE pushbutton switch as required to reach the desired range.

2. A power-selection switch has been added to the rear of the instrument.
   a. The unit is shipped from the factory with this switch in the "115" position and a 0.5 ampere fuse installed.
   b. If it is desired to operate from a 230 VAC power source, change the fuse to 0.25 ampere and move the selection switch to the "230" position.

3. Utilize Schematic Diagram 35-92 for the LX-2A Main Board Assembly and Schematic Diagram 35-93 for the LX-2A Function Switching Assembly.

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|---|---|
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# CHAPTER I

# INTRODUCTION AND SPECIFICATIONS

## 1-1. GENERAL DESCRIPTION

1-2. The NLS Series LX-2 is a four-digit Multifunction meter with automatic range and polarity selection. The instrument measures DC voltage in four ranges, AC voltage in four ranges, resistance in four + one ranges and has external reference capability in all functions and ranges. Twenty percent over-ranging is provided in most ranges and functions (See specifications for exceptions). The instrument may be used as a bench model or, with the use of rack-mounting adapters, may be rack-mounted in a standard 19-inch mounting rack.

## 1-3. OPTIONAL ACCESSORIES

1-4. Accessories available for the Series LX-2 are:

Data Output
Rechargeable Battery Pack
Rack-Mounting Kit
High Voltage Probe
Current Shunts
Input Cable

## 1-5. OPERATING PRINCIPLE

1-6. In these instruments, the unknown input is isolated and used to charge a capacitor during a specific time interval. An internal reference is then applied to discharge the capacitor. Measuring the time interval required to discharge the capacitor indicates the unknown input.

## 1-7. DATA OUTPUT OPTION

1-8. The instrument possesses a printout and remote triggering capability (8-4-2-1 BCD) for operation with Data Printers, Tape Punches, Typewriters, and other recording devices.

## 1-9. BATTERY OPTION

1-10. A rechargeable battery power pack, housed inside the instrument's case, provides more than six hours of operation, free of main power lines. The power pack "floats" on line under normal operation maintaining the batteries at full charge. A front panel recharge indicator light provides an instantaneous display of low charge state.

## 1-11. INPUT CONNECTIONS

1-12. For maximum flexibility, the instrument has an isolated chassis (connected to the third pin of the power plug) and four input terminals - Signal HI, Signal LO, EXT. REF. and GUARD. This allows the user isolation from common ground, permits the internal guard shielding to be connected to external common-mode voltages, reducing common-mode effects and permits isolated input signal leads. See specifications for allowable voltages between input terminals.

## 1-13. COMMON-MODE-REJECTION

1-14. Rejection of common-mode signals, those caused by AC or DC currents flowing between signal source ground and instrument chassis ground, is a feature of the Series LX-2 DVM. (To obtain the highest common-mode-rejection, the shorting strap between Signal LO and GUARD should be removed and the GUARD terminal connected to the common-mode signal source. Common-mode signal rejection is important in a wide range of applications - testing complex electrical

and electronic systems, in automatic measuring systems, and measuring outputs from thermocouples, strain gages and other transducers where common-mode signals may be many times greater than the measured DC. voltage.

## SPECIFICATIONS

| MODE | RANGE | 30 DAY ACCURACY | RESOLUTION | TEMPERATURE COEFFICIENT | INPUT RESISTANCE |
|---|---|---|---|---|---|
| Volts DC | 1.1999<br>11.999<br>119.99<br>1000.0 | ASA Reference Conditions<br>±(0.02% Rdg + 0.008% FS) | 100 μV<br>1 mV<br>10 mV<br>100 mV | ±(0.0025% Rdg + 0.0008% FS)/°C | 10 MΩ |
| Volts AC | 1.1999<br>11.999<br>119.99<br>1000.0 | 50 Hz to 10 KHz; Usable,<br>30 Hz to 20 KHz - Slight<br>degradation of accuracy<br>±(0.1% Rdg + 0.04% FS) | 100 μV<br>1 mV<br>10 mV<br>100 mV | ±(0.01% Rdg + 0.0016% FS)/°C | 1 MΩ, < 100pF |
| KΩ | 1.1999<br>11.999<br>119.99<br>1250.0 | ±(0.02% Rdg + 0.008% FS) | 100 MΩ<br>1 Ω<br>10 Ω<br>100 Ω | ±(0.0035% Rdg + 0.0012% FS)/°C | Test Voltage<br>-17V across open input<br>1.2V at FS |
| $10^4$ KΩ (10 MΩ) Manual | 12500 | ±(0.05% Rdg + 0.008% FS) | 1000 Ω | ±(0.0035% Rdg + 0.0012% FS)/°C | 1.25V at FS |
| EXT. REF. (+8 to +10.5V) | Selecting this mode does not change the input conversion properties of the instrument with respect to decimal location, range selection, accuracy or resolution | | | ±0.0025% Rdg + 0.0008% FS)/°C<br>+ T.C. of above mode selected | > 10 MΩ |

| MAXIMUM INPUT VOLTAGES | |
|---|---|
| Signal Hi to Signal Lo | VDC: ±1000V Peak<br>VAC: ±1500V Peak with no more than 600 VDC component<br>KΩ: ±300V Peak<br>$10^4$ KΩ (10 MΩ): ±1000V Peak |
| Ext. Ref. to Signal Lo | All Functions and Ranges: ±50V Peak |
| Signal Lo to Guard | All Functions and Ranges: ±100V Peak |
| Guard to Chassis | All Functions and Ranges: ±500V Peak |

## SPECIFICATIONS (CON'T)

| | |
|---|---|
| READING SPEED (All Modes): | 500 milliseconds - Filter Out<br>1 second - Filter In |
| COMMON-MODE-REJECTION:<br>(with 1KΩ unbalance) | 120 db DC to 60 Hz - Filter In<br>100 db @ 50 Hz - Filter Out |
| NORMAL-MODE-REJECTION: | 60 db @ 60 Hz - Filter In<br>40 db @ 60 Hz - Filter Out |
| OPERATING TEMPERATURE RANGE: | 10°C to 50°C without Batteries<br>10°C to 50°C with Batteries during Discharge<br>10°C to 35°C with Batteries during Line Operation |
| STORAGE TEMPERATURE RANGE: | -40°C to 75°C (-40°C to 60°C with Batteries) |
| OPERATING HUMIDITY RANGE: | 80% Relative Humidity - Maximum |
| POWER: | 115 ±10V/230 ±20V<br>50-400 Hz - 8 Watts (15 Watts with Batteries) |
| WEIGHT: | 9.5 lbs. (12 lbs. with Batteries) |
| SIZE: | 8-1/2" W X 3-1/2" H X 15" D |
| PRINTER OUTPUT: | 1-2-4-8 BCD<br>Logic "0" = 0 to +0.4V<br>Logic "1" = > +2.4V |

*Specifications Subject to Change Without Notice*

# CHAPTER II

# INSTALLATION AND OPERATION

## 2-1. UNPACKING

2-2. The instrument is shipped in a heavy cardboard container. Cut the tape on the top of the container and open. If damage is observed, promptly notify the carrier. Immediately check the packing slip for possibility of shortages.

## 2-3. POWER SOURCE

2-4. The instrument is usually supplied for operation from 105-125-volt, 50-400 Hz, single phase power sources. However, the instrument will operate from 210-250-volt, 50-400 Hz, single phase sources if the two primaries of the power transformer are wired in series instead of parallel.

2-5. The LX-2 may be operated from an internal rechargeable battery pack if equipped with the battery option. The batteries charge automatically when the instrument is connected to the power line and turned on. Removing the power cord from the power line places the instrument in battery mode.

## 2-6. FUSING

2-7. The instrument is protected by a 3AG 1/2 ampere Slo-Blo fuse (F1) which is located adjacent to the power transformer.

2-8. When a 210-250-volt power source is to be used (and the power transformer primary rewired as indicated above). it is recommended that a 1/4 ampere Slo-Blo fuse be used to provide maximum protection. An 8AG 1/100 ampere fuse is used to protect the ohmmeter circuitry against application of external voltages. This fuse is located on the function switching assembly.

The rechargeable battery option incorporates a 3AG 4 ampere Slo-Blo fuse which is located on the converter board.

## 2-9. POWER GROUNDING

2-10. The third pin of the power plug grounds the outer chassis of the instrument (Figure 2-1). Despite the presence of the third grounding pin, there is no real assurance that the instrument will be corrrctly connected since the power outlets in many installations are erroneously wired. Be certain that the power source is in agreement with the power and grounding requirements of the instrument.

## 2-11. CONNECTORS (Figure 2-2)

2-12. Four input connectors are located on the front panel of the instrument. They are color-coded and labeled as to function:

| | |
|---|---|
| Signal HI | Red |
| Signal LO | Black |
| Guard | Blue |
| External Reference | Yellow |

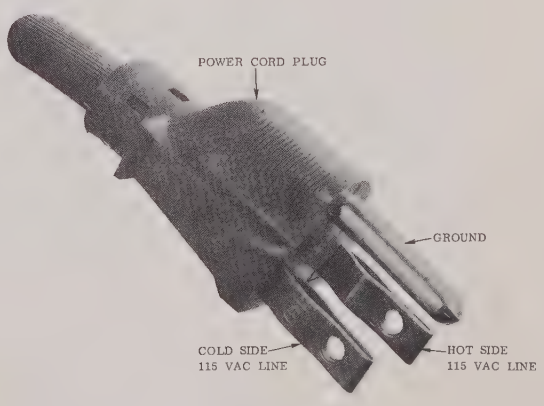



Figure 2-1. Power Plug Pin Coding

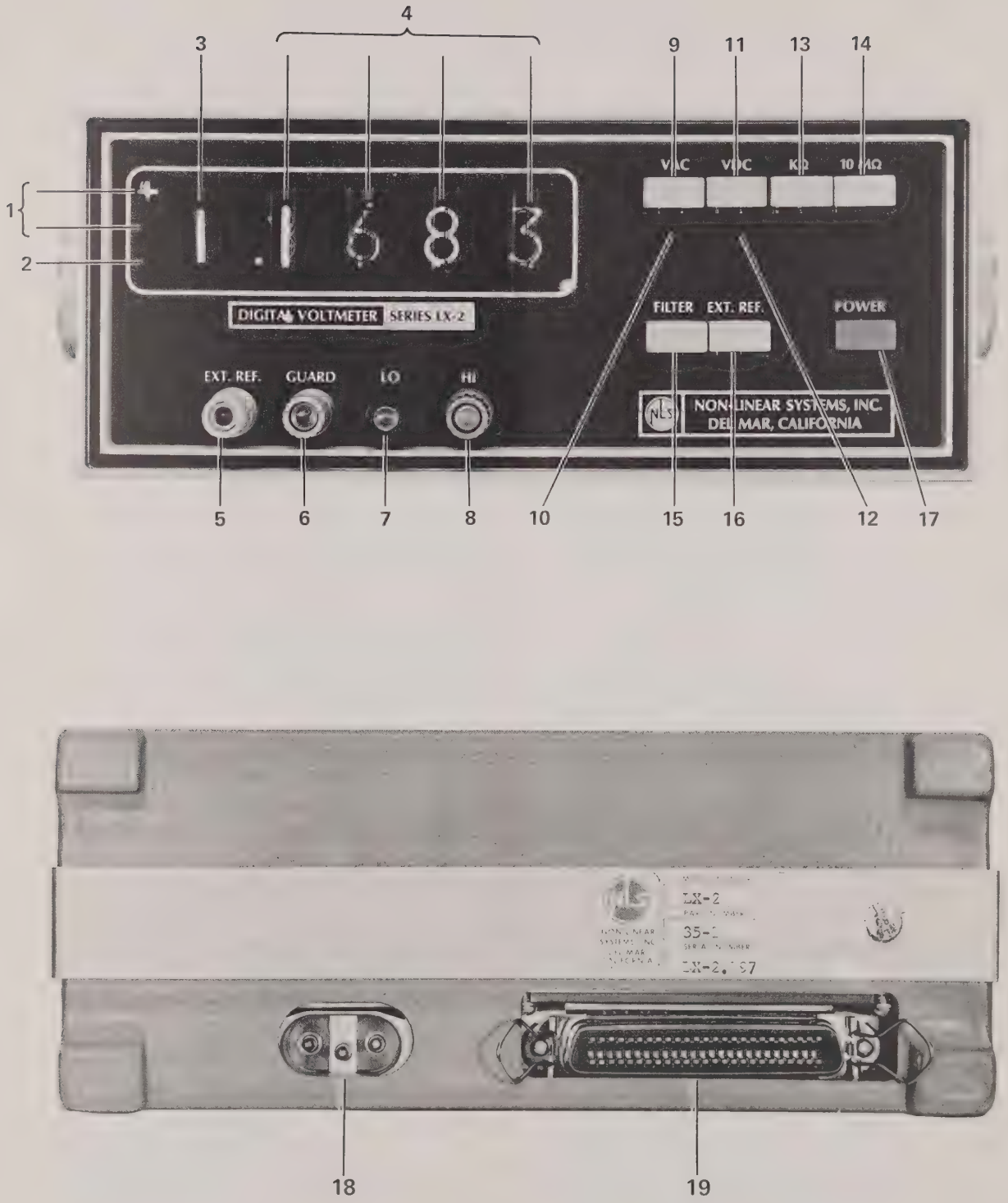



Figure 2-2. Front and Rear Views

| REF | TITLE | DESCRIPTION |
|---|---|---|
| 1 | Polarity Indicators | Incandescent bulbs behind mask indicate polarity of DC voltage applied to HI terminal with respect to LO terminal in VDC mode. |
| 2 | Battery Lo Indicator | Incandescent bulb behind mask indicates that the batteries have insufficient charge to properly power the instrument when the battery option is installed and the instrument is being operated from the batteries. This indicator also turns on when the line voltage is too low and the battery option is installed. |
| 3 | Over-range Indicator | Neon bulb displays over-range "1" corresponding to 10,000 digits. |
| 4 | Readout Tubes | Gas discharge display tubes which provide the readout in decimal form. There are four plug-in tubes, each containing the numerals 0 thru 9 and a decimal point. |
| 5 | External Reference Terminal | Input connection for external reference voltage. The external reference voltage must have a common connection with the input signal being measured. Acceptable voltage range applied this terminal is +8 volts to +10.5 volts. |
| 6 | Guard Terminal | Connects to inner guard shield. This terminal must always be connected either to signal LO by the shorting strap provided or to a source of common-mode voltages to provide increased rejection of common-mode signals. |
| 7 | Signal LO Terminal | Connects to instrument signal common. All measurements are made with respect to this terminal. |
| 8 | Signal HI Terminal | Connects to instrument signal input. All measurements are made of the voltage or resistance applied to this terminal. |
| 9 | VAC Switch | Push button switch selects AC voltage measurements. Button "in" indicates readout is displaying AC volts (AC converter is average responding, calibrated in RMS). |
| 10 | AC Zero | Front panel zero control which will adjust the readout to 0.000 VAC when signal HI and LO are shorted together (DC zero should be checked first). |
| 11 | VDC Switch | Push-button switch selects DC voltage measurement. Button "in" indicates readout is displaying DC volts, including polarity. |
| 12 | DC Zero | Front panel zero control which will adjust the readout to ±0.000 VDC when signal HI and LO are shorted together. |
| 13 | KΩ Switch | Push-button switch selects KΩ resistance measurement. Button "in" indicates readout is displaying kilohms. |
| 14 | $10^4$KΩ (10MΩ) Switch | Push-button switch selects KΩ resistance measurement above 1.25 megohms. Button "in" indicates readout is displaying kilohms with the decimal understood to be to the right of the least significant digit. |
| 15 | Filter Switch | Push on-push off switch controls the amount of input filtering and the reading rate of the instrument. Button "in" provides increased filtering and slower reading rate. |
| 16 | External Reference Switch | Push on-push off switch selects external reference voltage or internal reference voltage. Button "in" indicates measurement is made using the voltage applied to the EXT. REF. terminal (See Figure 2-3 for calibration of reading). Button "out" indicates readout is displaying absolute units as described in References 9, 11, 13 and 14 of this Table. Application of voltage to EXT. REF. terminal does not affect calibration of instrument until EXT. REF. button is "in". |
| 17 | Power Switch | Push on-push off switch controls main power to instrument. Button "in" turns instrument on. |
| 18 | Power Connector | Three-pin connector accepts power from AC line source. |
| 19 | Output Connector | Fifty-pin connector (optional) provides transfer of measurement data to external recording device. |

Figure 2-2. Front and Rear Views (Sheet 2 of 2)

2-13. A 3-pin AC connector is located on the rear panel of the instrument and mates with the line cord termination.

2-14. Instruments purchased with the optional data output feature will have a 50-pin connector also located on the rear panel.

2-15. CONTROLS AND DISPLAYS

2-16. See Figure 2-2 (Sheets 1 and 2).

2-17. OPERATION

1. Plug proper end of power cord into rear of instrument and other end into a 115 VAC, 50-400 Hz power source. (If the optional battery pack is being used for the first time, it may be necessary to plug instrument into the power line and turn instrument on for at least 8 hours to charge the batteries - it can take up to 16 hours to fully charge a set of fully discharged batteries).
2. Connect the guard terminal with the LO terminal using the shorting strap provided.
3. Connect input leads to Signal Hi and Signal Lo terminals. (Lead resistance should be less than 0.1Ω to avoid measurement errors.)
4. Switch instrument on by depressing power push button.

2-18. MEASURING DC VOLTS

1. Switch into DC volts mode by depressing VDC button. Ensure that EXT. REF. button is in the "out" position.
2. Short circuit input leads - readout should register 0.000. (If necessary, the readout may be zeroed by readjusting the zero adjust control with a small screwdriver inserted in hole directly under VDC button.)
3. DC volts may be measured by connecting input leads to voltages of interest. The instrument will select the proper range automatically, displaying the voltage, decimal point and polarity of the input HI terminal with respect to the input LO terminal.
4. Depressing the filter button, switches in a filter, increasing the instruments ability to reject noise. Using the filter decreases the speed per reading from 0.5 second to 1 second.
5. High voltage measurements, between 1 KV and 30 KV may be made with the use of the optional probe which provides an attenuation of 1,000:1.

2-19. MEASURING AC VOLTS

1. Switch into AC volts mode by depressing VAC button.
2. Short circuit input leads - readout should register 0.000. (If necessary, the readout may be zeroed by readjustment of the AC zero adjust control with a small screwdriver inserted in the hole directly beneath the VAC button.
3. AC volts may be measured by connecting input leads to AC voltages of interest. The instrument will select the proper range automatically, displaying AC voltage and decimal point.

2-20. MEASURING RESISTANCE

1. Switch into Kohms mode by depressing KΩ button.
2. Short circuit input leads - readout

should register 0.000 KΩ. If the readout does not display 0.000KΩ, recheck the DC zero (paragraph 2-18, step 2). If the DC zero is properly set, then the meter is displaying the resistance of the test leads. For best accuracy, test leads should be used with a series resistance of less than 0.1Ω. However, reading accuracy may be maintained if the test lead resistance measured by the instrument is subtracted from the reading taken on an unknown resistor; i.e. test lead reading = .0020KΩ, unknown reading = 9.675KΩ, compensated reading = 9.675 - .002 = 9.673KΩ.

3. Resistance may be measured by connecting the input leads to the unknown resistance. The instrument will select the proper range automatically displaying the resistance in KΩ and the decimal point.

4. To make measurements in the 10 MΩ range, depress the $10^4$KΩ (10MΩ) button. The instrument will display the resistance in KΩ with the decimal point understood to be to the right of the least significant digit, but not actually displayed; i.e. 12500KΩ.

NOTE

The test configuration used is two-wire constant current. The test currents are: 1K range - 1mA, 10K range - 100μA, 100K range - 10μA, 1000K range - 1μA, 10,000KΩ range - 100nA. The polarity of the test voltage across the unknown resistor is negative at the Signal HI terminal with respect to the Signal LO terminal.

## 2-21. OPERATION WITH AN EXTERNAL REFERENCE

1. Connect an external reference voltage from +8 to +10.5V between the EXT. REF. and LO terminals.

2. Switch into external reference mode by depressing the EXT. REF. button.

3. The instrument will now display the ratios of input to external reference. (See Figure 2-3.)

| BUTTONS DEPRESSED | READING DISPLAYED |
|---|---|
| VDC and EXT. REF. | $10 \times \frac{\pm\text{Input VDC}}{\text{Ref. VDC}}$ |
| VAC and EXT. REF. | $10 \times \frac{\text{Input VAC}}{\text{Ref. VDC}}$ |
| KΩ and EXT. REF. | $10 \times \frac{\text{Input K}\Omega}{\text{Ref. VDC}}$ |
| $10^4$KΩ (10MΩ) and EXT. REF. | $10 \times \frac{\text{Input K}\Omega}{\text{Ref. VDC}}$ |

Figure 2-3. Ratio Reading Calibration

# CHAPTER III

# THEORY OF OPERATION

## 3-1. INTRODUCTION

3-2. The LX-2 electronics may be divided into two basic sections, a Signal Conditioning Section and a Digitizing Section. The Signal Conditioning Section processes resistance measurements and DC and AC voltage inputs into a normalized DC analog signal. The Digitizing Section accepts the normalized DC analog signal.

3-3. Subdivisions within this chapter describe the various circuits making up each section. An overall block and logic diagram is shown in Figure 3-1.

## 3-4. SIGNAL CONDITIONING SECTION

3-5. In order to provide a normalized DC analog signal to the Digitizing Section, it is necessary to convert AC and resistance measurements to DC which can then be digitized. Since the input signal is compared with an internal reference, it is necessary to attenuate input signals greater than the internal reference. The input attenuator and signal conditioning for DC, AC and resistance measurement will be discussed in paragraphs 3-6 thru 3-15.

### 3-6. SIGNAL CONDITIONING FOR VOLTS DC (Figure 3-2)

3-7. The volts DC mode has four ranges; 1.1999, 11.999, 119.99 and 1000V full scale. The auto-range attenuator is set to the proper range by logic circuits which actuate the range relays. The attenuator output is voltage-limited by a protective circuit to no more than + or - 3 VDC so that the filter and amplifier will recover quickly from overloads. The attenuator output feeds a filter which attenuates unwanted AC signals and noise. Additional filtering may be switched on by use of a front-panel switch. The output of the filter is applied to the buffer-amplifier, Q57 and A20. Q57 is a dual F.E.T. low noise, low drift, high input impedance device which drives A20, a monolithic operational amplifier; the combination provides an open loop gain of about $3 \times 10^6$.

3-8. The output of A20 is connected through a diode bridge and then returns to Q57, completing a negative feedback loop, making Q57-A20 a combination input buffer, polarity inverter and integrating amplifier. The diode bridge functions to charge capacitors C25 thru C28 in the same direction regardless of signal polarity at the input terminals. The charge on these capacitors is the normalized DC analog signal. Since the output of the buffer-amplifier may be of either polarity, it is used to actuate circuitry which will indicate polarity by lighting DS3 or DS4.

### 3-9. SIGNAL CONDITIONING FOR VOLTS AC (Figure 3-3)

3-10. The volts AC mode has four ranges; 1.1999, 11.999, 119.99 and 1000V full scale. Depressing the VAC push button connects the SIG Hi terminal to the AC volts signal conditioning circuits and switches the DC output of these circuits to the input of the DC signal conditioning circuits. AC signals are connected to C10, R39, CR5, and CR6, and the input of amplifier A1. C10 blocks DC, allowing AC to pass. R39 and CR5 and CR6 act as a voltage-limiting circuit protecting the input to amplifier A1. A1 is a monolithic operational amplifier in a negative feedback loop.

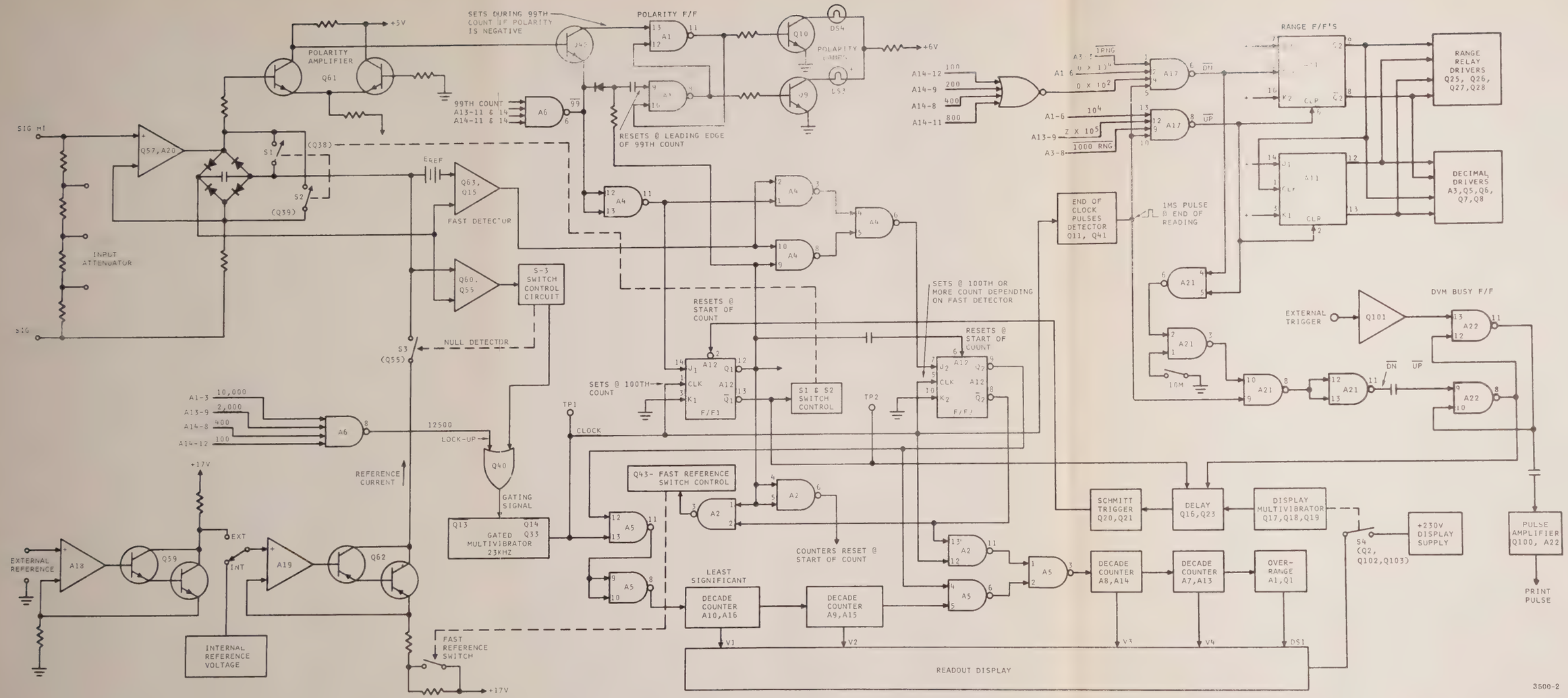



Figure 3-1. Logic Diagram - Series LX-2 DVM

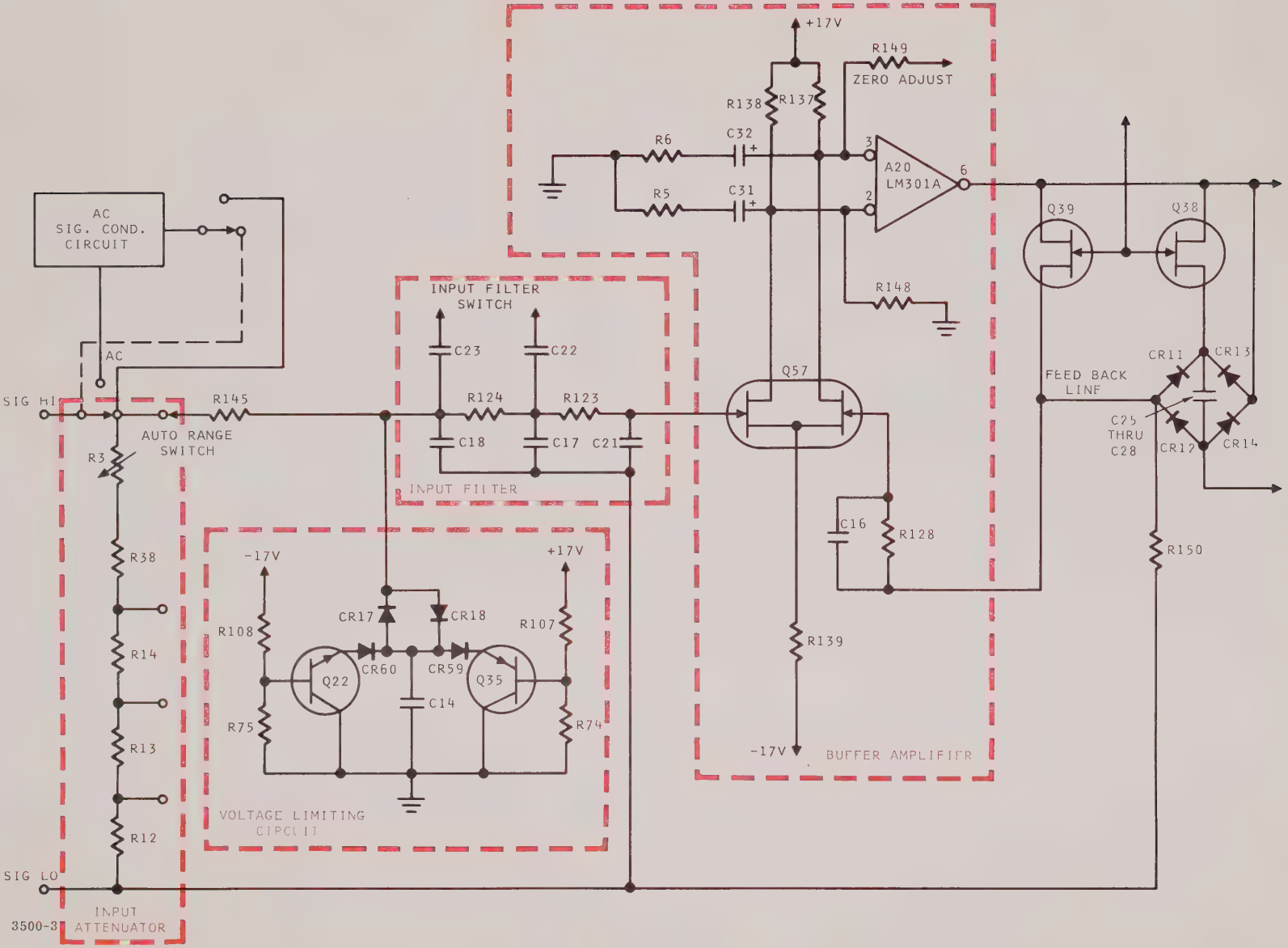



Figure 3-2. Simplified Diagram - Input Attenuator and DC Volts Signal Conditioning Circuits

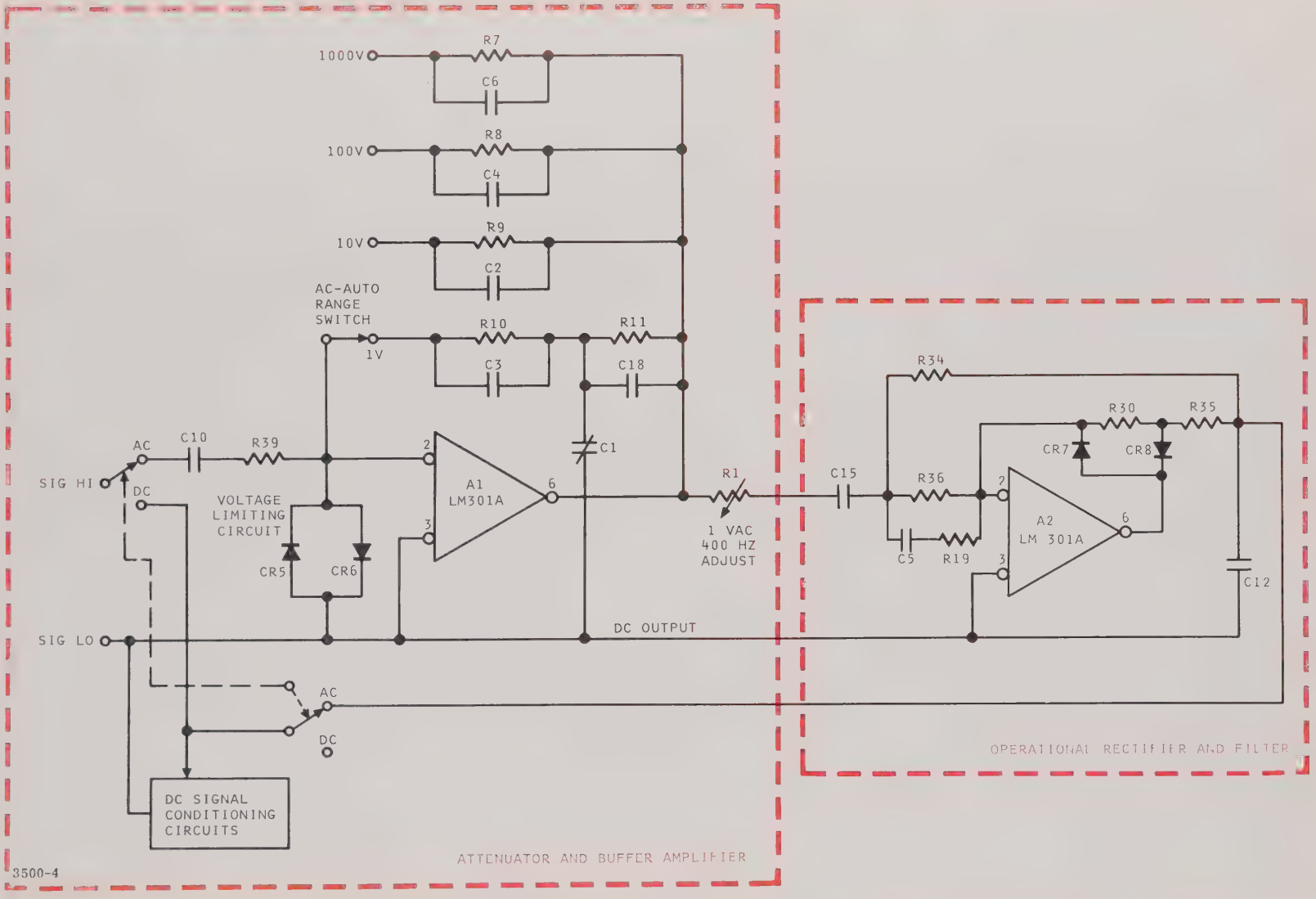



Figure 3-3. Simplified Diagram - AC Volts Signal Conditioning Circuits

The gain of A1 is determined by the ratio of the input resistor R39 to R7, through R11. The output of A1 goes through R1, a calibration adjustment, coupling capacitor C15 and input resistor R36 to the input of A2, a second operational amplifier. Diodes CR7 and CR8, placed inside the negative feedback loop around A2, form an operational full-wave rectifier, whose DC output is filtered by R34, R35 and C12. In the AC volts mode, range attenuation is accomplished by switching feedback resistors R7 thru R11 around A1. As in the DC volts mode, this is done automatically by the logic circuits which actuate the proper relays. To compensate for losses in rectification and filtering, A1's normal range attenuation is reduced by one-half and A2 has a gain of 2X.

3-11. SIGNAL CONDITIONING FOR RESISTANCE MEASUREMENT (Figure 3-4)

3-12. The KΩ mode has four ranges; 1.1999, 11.999, 119.99 and 1250.0KΩ. An additional manually selected range of $10^4$KΩ (10 megohms) provides a display of 12500KΩ. Resistance measurements are made by measuring the voltage drop across a resistance under test ($R_X$) through which a known stable current is passing. To read the proper value, current passing through $R_X$ must be proportioned so that one unit of the resistance being measured is equal to one digit displayed in the readout. This requires precise current steps when switching from range to range (four lower ranges).

3-13. A constant current supply and regulator circuit incorporating Q1, Q2, Q3 and Q6 forms the precision current source. The instrument's internal reference supply is used as a reference voltage for the constant current supply. The buffer-amplifier feedback voltage is used to maintain a constant current through $R_X$, compensating for differing values of $R_X$.

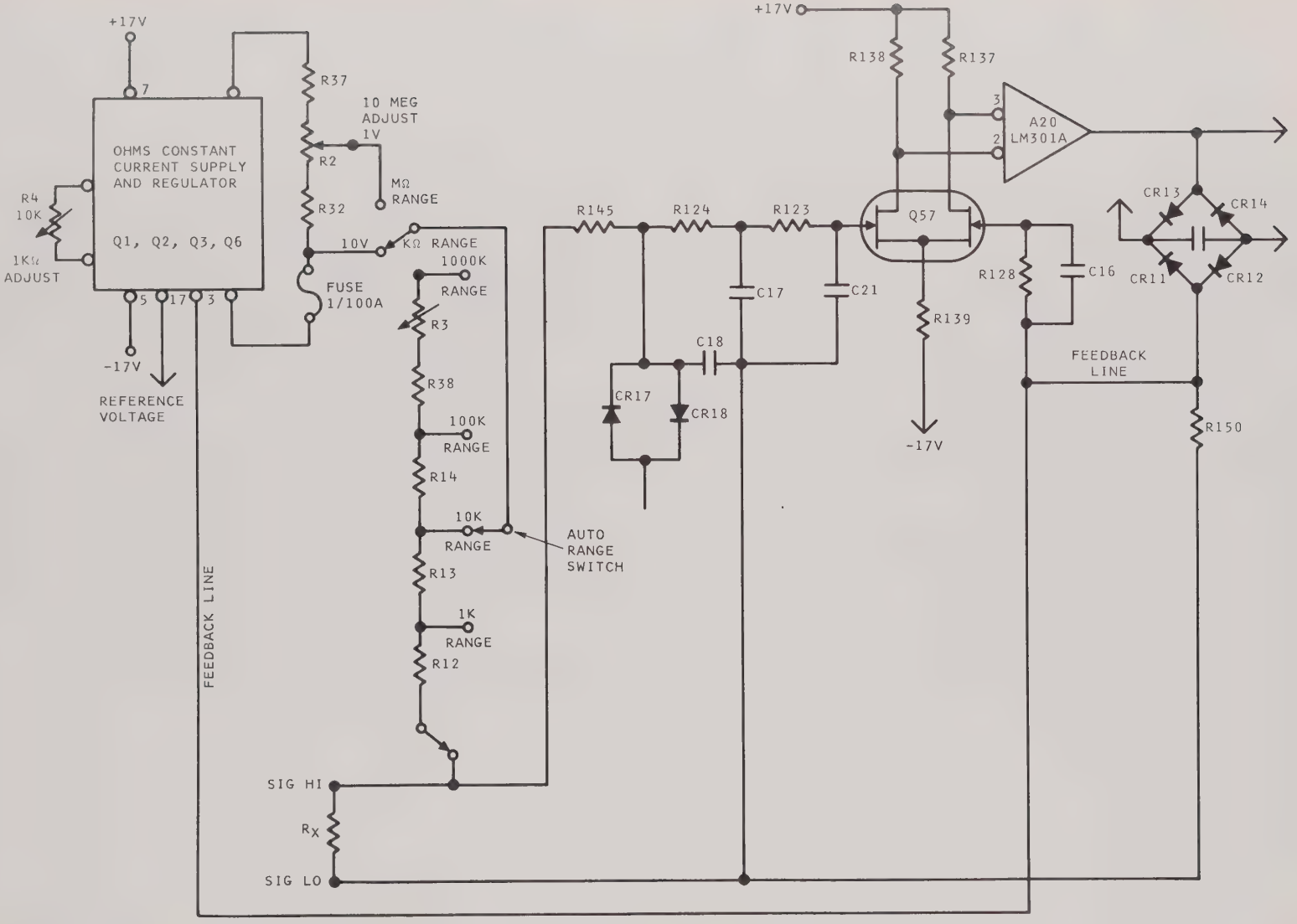
3-14. A 1/100A fuse is used to protect the regulator current from inadvertant contact with voltage sources when in the KΩ or $10^4$KΩ modes.

3-15. In the KΩ measuring mode, the DC input attenuator is connected between the constant current supply and $R_X$. The attenuator now becomes a series of precision resistors which is switched by the logic circuits, forming an auto-ranging ohmmeter in these four lower ranges.

3-16. DIGITIZING SECTION (Figure 3-5)

3-17. The Digitizing Section functions to accept the normalized DC analog signal and process it so that it may be displayed digitally with the proper decimal and polarity signs.

3-18. The Digitizing Section contains two multivibrators which generate timing periods and clock pulses. Basic timing of the instrument is set by the Display Timer, a 50 Hz/sec multivibrator which produces an assymetrical 4-mSec - 20-mSec rectangular waveform. During the 4-mSec period, the readout lamps are illuminated, displaying the instrument's reading. The end of the 4-mSec period triggers on the digitizing period which lasts for 20 mSec. At the instant the digitizing period starts, the counters are reset, the 23K Hz clock multivibrator is gated on and applied to the counters. The buffer-amplifier output is gated, allowing C25 thru C28 to charge. At the end of 100 clock pulses, the counters are reset, C25 thru C28 are switched to a constant current reference source which discharges the capacitors at a specific rate. Level sensing circuits determine whether a "Fast" or "Slow" discharge rate is to be switched in. The "Fast" rate is automat-




3500-5

**Figure 3-4. Simplified Diagram - Resistance Measuring Signal Conditioning Circuits**

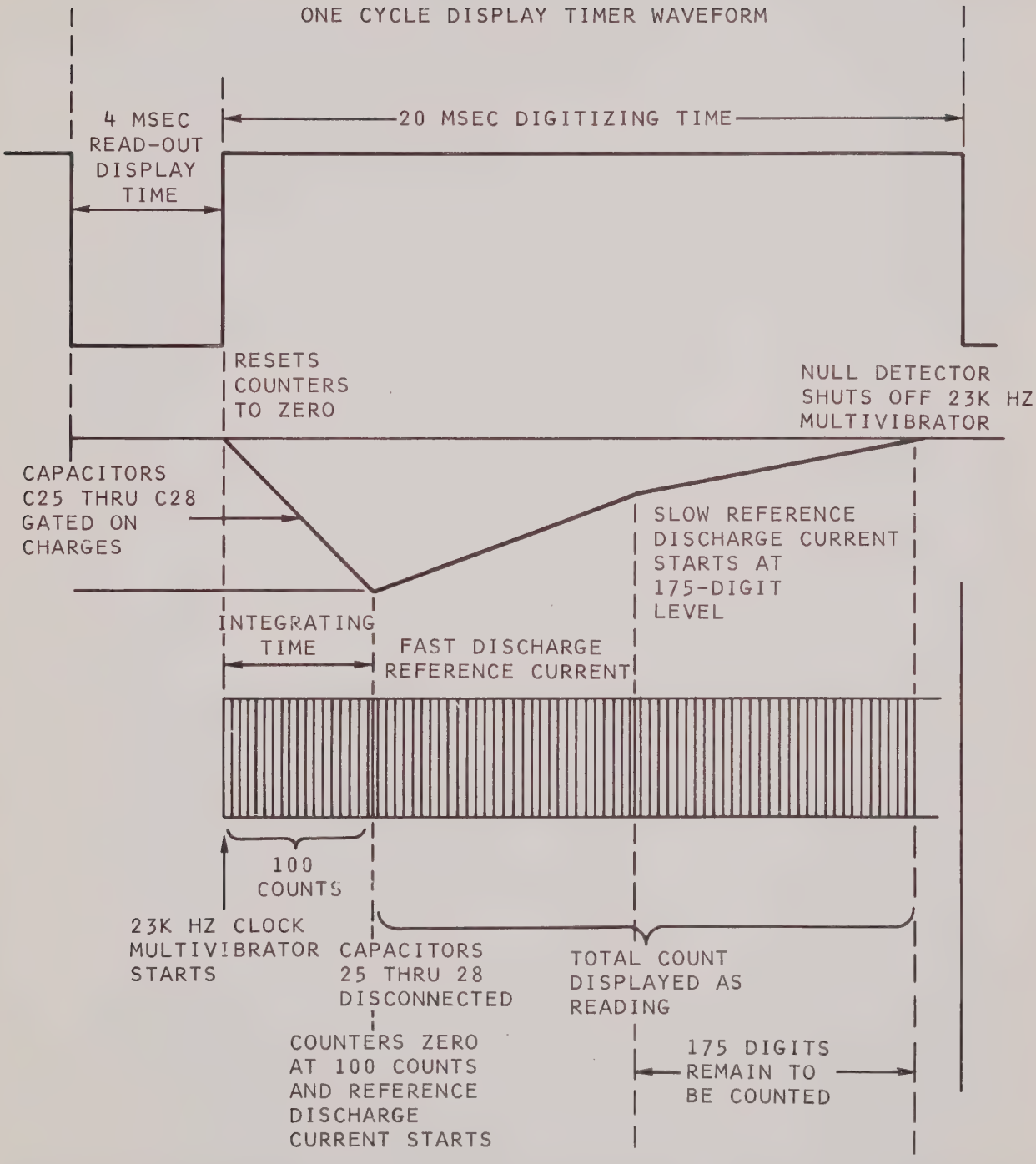

ONE CYCLE DISPLAY TIMER WAVEFORM
4 MSEC READ-OUT DISPLAY TIME
20 MSEC DIGITIZING TIME
RESETS COUNTERS TO ZERO
NULL DETECTOR SHUTS OFF 23K HZ MULTIVIBRATOR
CAPACITORS C25 THRU C28 GATED ON CHARGES
SLOW REFERENCE DISCHARGE CURRENT STARTS AT 175-DIGIT LEVEL
INTEGRATING TIME
FAST DISCHARGE REFERENCE CURRENT
100 COUNTS
23K HZ CLOCK MULTIVIBRATOR STARTS
CAPACITORS 25 THRU 28 DISCONNECTED
TOTAL COUNT DISPLAYED AS READING
COUNTERS ZERO AT 100 COUNTS AND REFERENCE DISCHARGE CURRENT STARTS
175 DIGITS REMAIN TO BE COUNTED
3500-6

Figure 3-5. Digitizing Section - Preliminary Discussion

ically switched to the "Slow" rate when about 175 digits remain to complete the reading. When the capacitors have discharged to the same level as when the digitizing period began, the Null Detector circuit shuts off the clock multivibrator.

3-19. The counters have counted a specific number of clock pulses during the discharge period, have set the decoding circuits, which have applied proper potential on the readout numerals, and the arrival of the 4-mSec display pulse illuminates the readout lamps with a digital display equal to the analog voltage.

3-20. DIGITIZING SECTION - CIRCUIT DESCRIPTION

3-21. Display Timer. Basic timing for the digitizing circuits is developed from the Display Timer Multivibrator circuit (Figure 3-6). Q17 and Q18 with the associated circuitry forms a 50 Hz/sec rectangular pulse generator with a 4-mSec pulse width and a 20-mSec recovery period. Q19 reduces loading on Q17 and Q18 and provides a low impedance path to Q102 which drives Q103 and Q2. This pair acts as a 4-mSec high voltage switch, pulsing the readout lamps.

3-22. Q19 also feeds Q16. Normally, Q16 feeds negative pulses to the Schmitt trigger, Q20-Q21. Under some conditions, such as auto-ranging, input filtering, etc., it is necessary to delay the digitizing circuits. This is done by Q23 which controls the charge on C35 which in turn sets the voltage level at the collector of Q16, thereby controlling the amplitude of the pulses that drive Schmitt trigger Q20-Q21. Insufficient pulse amplitude will inhibit Q20-Q21.

3-23. Integrating Time (Figure 3-7). The output of Schmitt trigger Q20-Q21 pulses pin 2 of Flip-Flop A12, resetting it and initiating the digitizing period. The following events occur when Flip-Flop A12 changes state:

(A) The voltage change at pin 12 of A12 is differentiated thru C5 and amplified by A2. The resultant pulse at pin 6 zeros the counters.

(B) The voltage change at pin 13 of A12 is coupled thru R51 to Q51 and Q44 which gates off Q38 and Q39, allowing the integrating capacitors C25 thru C28 to charge.

(C) Q51 also drives Q46, Q45 and Q40 which allows the clock multivibrator, Q13 and Q14 to start.

(D) Clock pulses from Q33 go to A2, whose output connects to A5, which drives counter A14.

(E) During the next part of the digitizing interval, counters A13 and A14 proceed to count clock pulses while the intergrating-capacitors charge from the buffer-amplifier. At the count of 99, the combined counter outputs gate A6. Gated A6 output (pin 6) drives A4 which changes the state of Flip-Flop A12 at the 100th clock pulse. The following events occur at the 100th clock pulse:

1. Counters A13 and A14 cycle to zero.

2. Q38 and Q39 switch on, connecting the integrating capacitors to the "Slow" reference discharge current.

3. Level sensing circuits determine the magnitude of the signal on the integrating capacitors. If an input of 175 digits or more is present, the "Fast" reference discharge becomes operative, making the discharge rate 100 times faster then the "Slow" rate.

4. In the "Slow" discharge mode, clock pulses are fed to pin 14 of A14. In the "Fast" discharge mode, clock pulses are fed to pin 14 of A16.

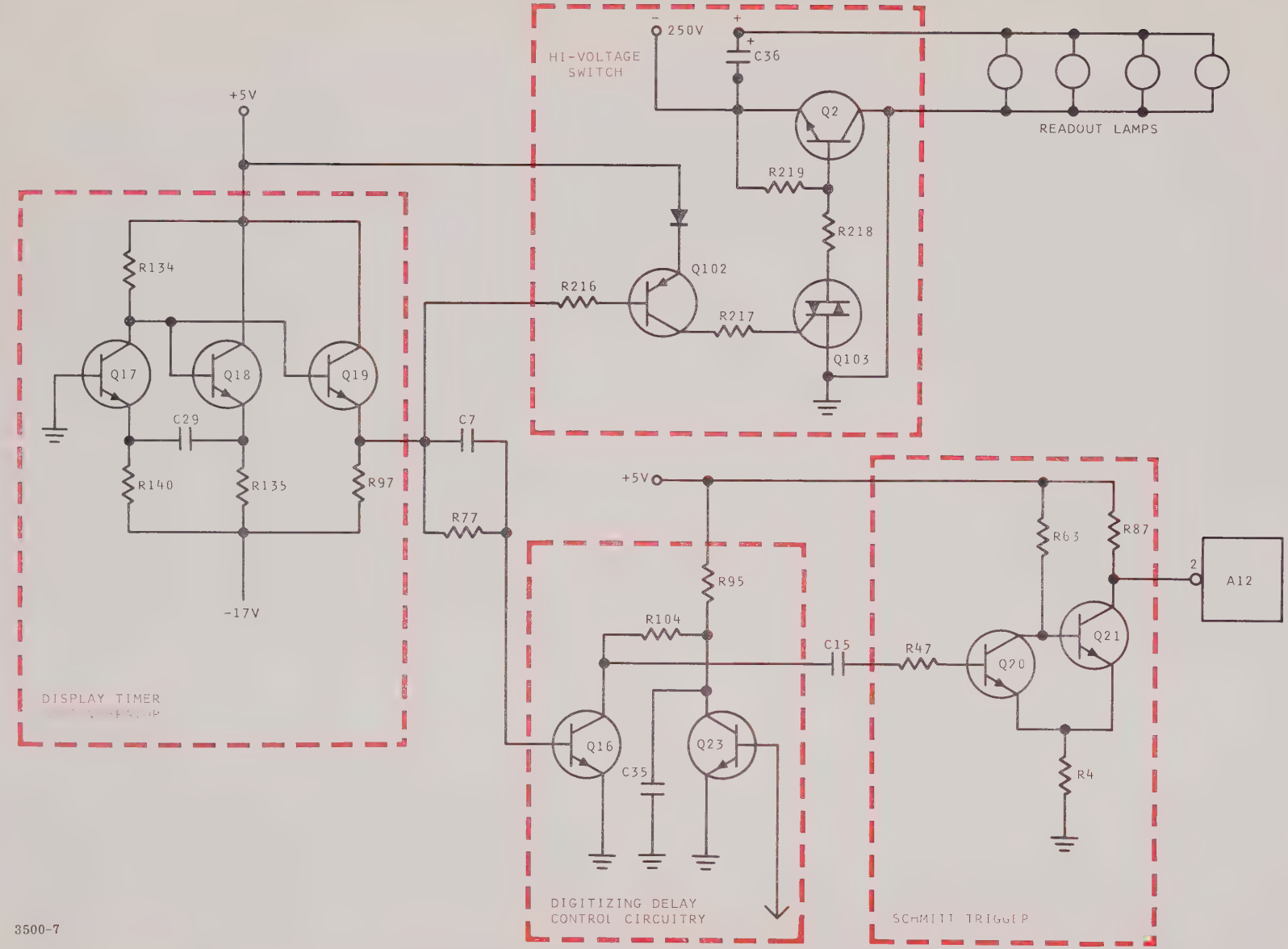



Figure 3-6. Simplified Diagram - Display Timer, Delay Control and High Voltage Circuits

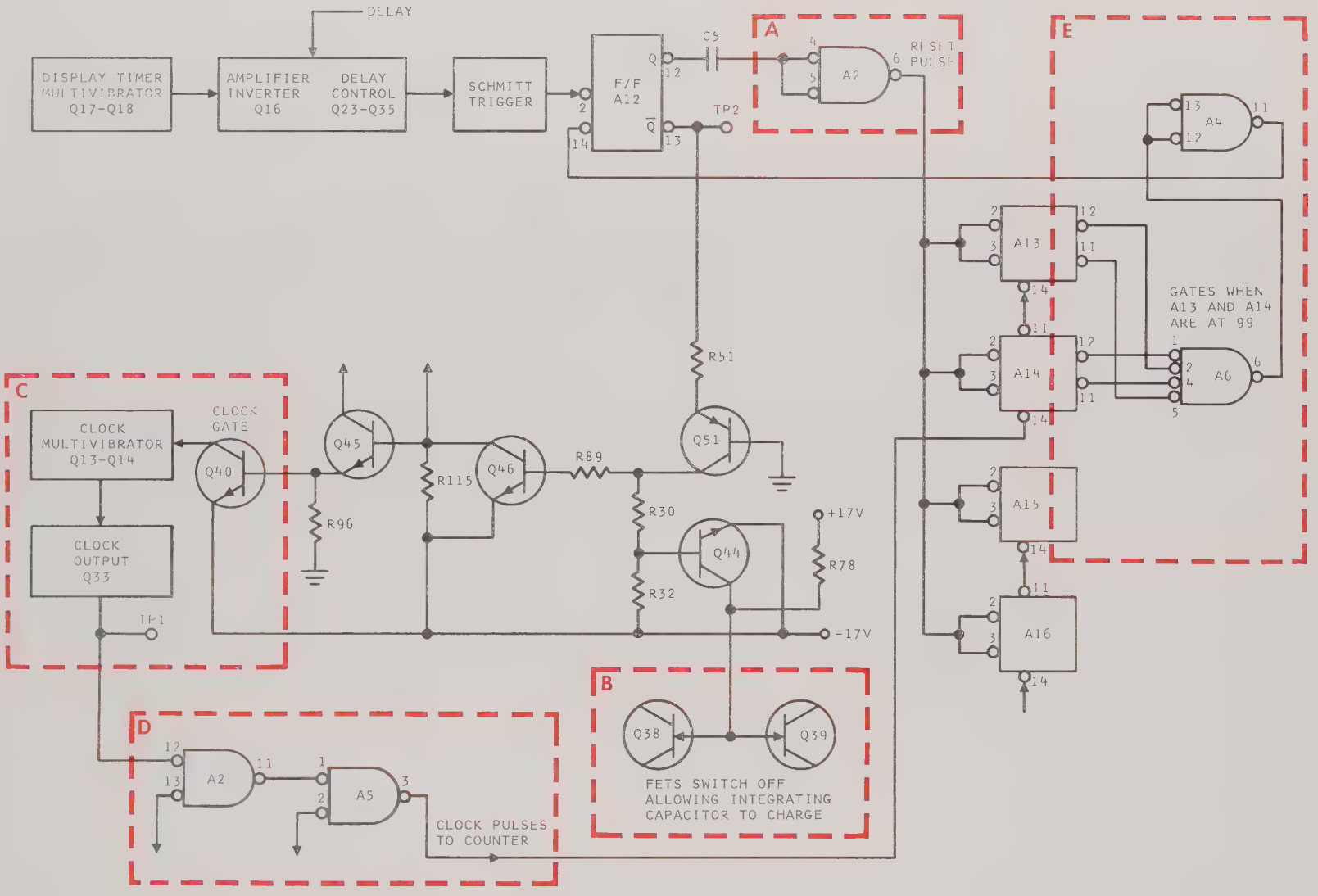



Figure 3-7. Simplified Diagram - Digitizing Circuits

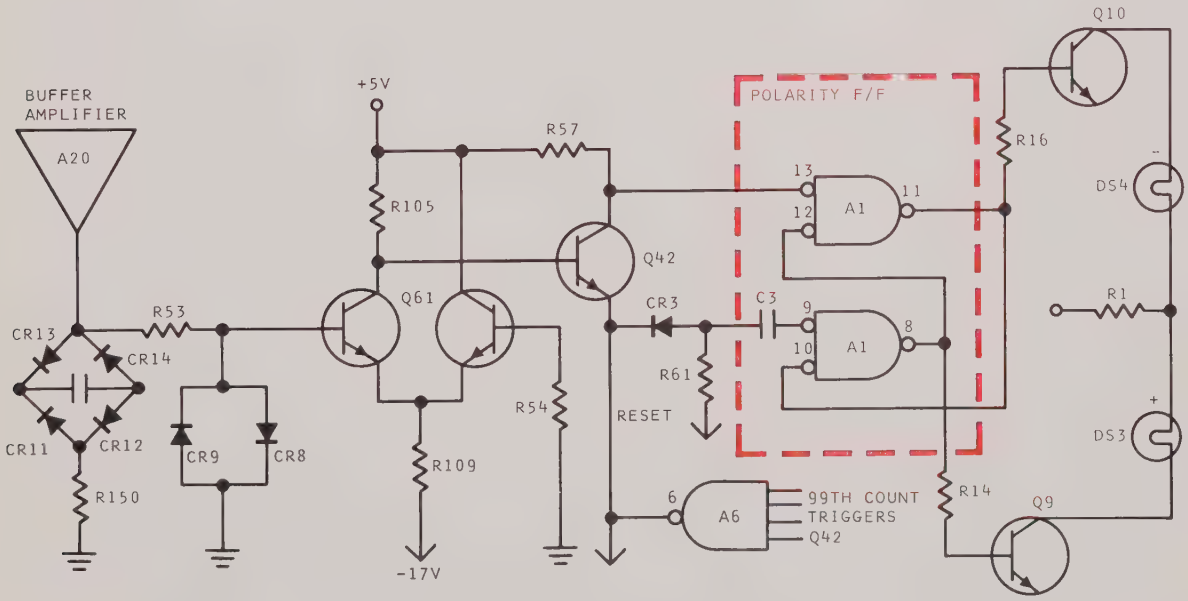
The digitizing period continues with the integrating capacitors discharging while clock pulses are being counted. If the level sensing circuits detect the 175 digit level during the discharge, the "Fast" reference discharge is switched out, leaving the "Slow" discharge rate. The count proceeds until the Null Detector input, Q60, senses that the integrating capacitors have discharged to the pre-digitizing state. At this point, clock gate control Q40 is actuated by Q45 in the Null Detector circuit, stopping the clock and the count. The digitizing period ends, followed by the 4-mSec Display Timer pulse which illuminates the count in the readout and resets the digitizing circuits.

3-24. POLARITY INDICATING CIRCUIT (Figure 3-8)

3-25. Polarity is determined at the end of every integrating period. The DC level at the output of the buffer-amplifier is fed to Q61, a differential transistor pair, through R53. CR7-CR8 limit signals of either polarity. Q61 is direct coupled to Q42 which drives the Polarity Flip-Flop, formed by two sections of A1.

3-26. The Polarity Flip-Flop is reset at the end of every integrating cycle by the output of A6 through CR3 and C3, sharply pulsing pin 9 of A1.

3-27. If a positive polarity is present, the Polarity Flip-Flop remains in the rest state, driving Q9 which lights "+" indicator lamp DS3. A negative polarity will cause the collector of Q42 to go negative when gated by A6, setting the Polarity Flip-Flop after every reset pulse which lights the "-" indicator lamp DS4.




3500-9

Figure 3-8. Simplified Diagram - Polarity Circuit

3-28. AUTO-RANGING CIRCUIT (Figure 3-9)

3-29. Auto-ranging is controlled by the states of two Flip-Flops, F-F 1 and F-F 2 in A11. The four auto ranges correspond to the four possible states of these two Flip-Flops. The outputs of the Flip-Flops actuate relay drivers Q25 thru Q28 which drive the range selecting relays. The Flip-Flop outputs are also decoded by four gates in A3 which feed decimal driver transistors Q5 thru Q8, illuminating the corresponding decimal light.

3-30. Up-Ranging. An up-range pulse is generated at the output of gate A17, pin 8, when the following conditions occur:

1. 12000 clock pulses are counted.

2. The over-range "1" is present.

3. The clock pulses cease (end of clock pulse detected by Q11 and Q41, gating pin 10 of A17).

An up-range pulse from pin 8 of A17 to pins 2 and 6 of Flip-Flop A11 places the instrument in its highest range.

3-31. Down-Ranging. A down-range pulse is generated at the output of gate A17, pin 6, when the following conditions occur:

1. The two most significant numbers in the readout are 00.

2. The clock pulses cease (end of clock pulses detected by Q11 and Q41, gating pin 5 of A17).

A down-range pulse at pin 16 of A17 causes the instrument to drop to the next lowest range.

3-32. DATA OUTPUT OPTION

3-33. The Data Output Option incorporates circuitry to permit external triggering of the instrument and provides a print pulse when a valid reading has been made. Data output is provided at the rear of the instrument through the output connector J9.

3-34. CIRCUIT DESCRIPTION (Figure 3-10)

3-35. The print pulse is generated when a Flip-Flop (formed by two sections of A22) is reset. An input trigger pulse sets the Flip-Flop. When the instrument determines that a reading has been made in the proper range, a reset pulse is generated, resetting the Flip-Flop which generated the print pulse. An external trigger grounding pulse is applied to pin 47 of the Data Output connector J9 causing Q101 to cut off. The collector of Q101 is tied to pin 13 of Flip-Flop A22, which sets.

3-36. The Flip-Flop will reset only when the following conditions are met:

1. A reading has been taken and clock pulses have ceased (Q41 detects end of pulses and gates A21 via pin 9.

2. Gate A21 (pins 4 and 5) has not detected an Up- or Down-range pulse from gate A17, pins 6 and 8.

3-37. The absence of both Up- and Down-range pulses plus the absence of clock pulses gates A21 via pins 9 and 10. The gate output at pin 8 is coupled through another section of A21 via pins 12 and 13, the output at lin 11 triggering the reset of Flip-Flop A22 at pin 9. When the Flip-Flop resets, the output change at pin 11 of A22 is capacitively coupled to Q100. Q100 feeds another

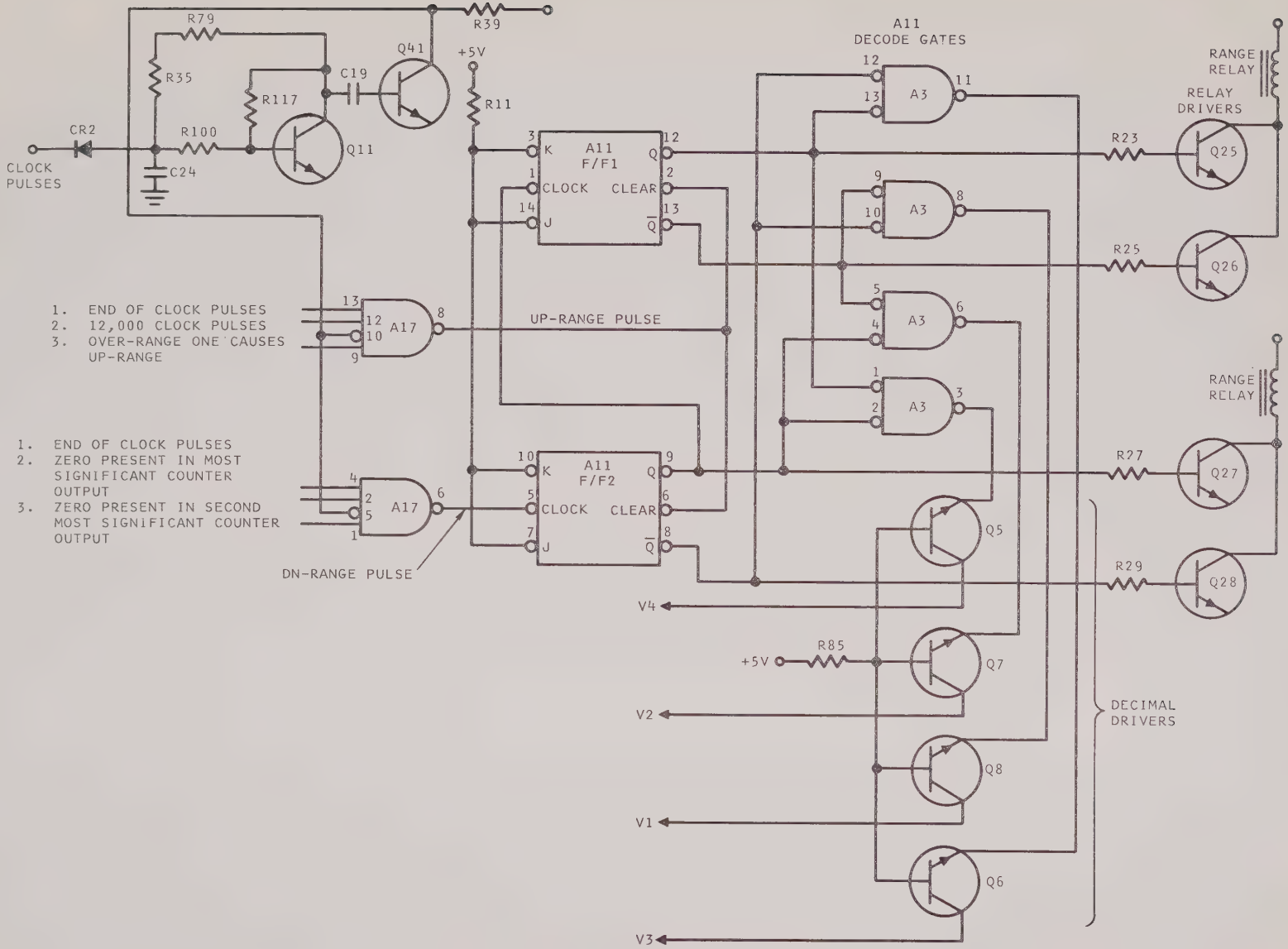



Figure 3-9. Simplified Diagram - Auto-Ranging Circuit

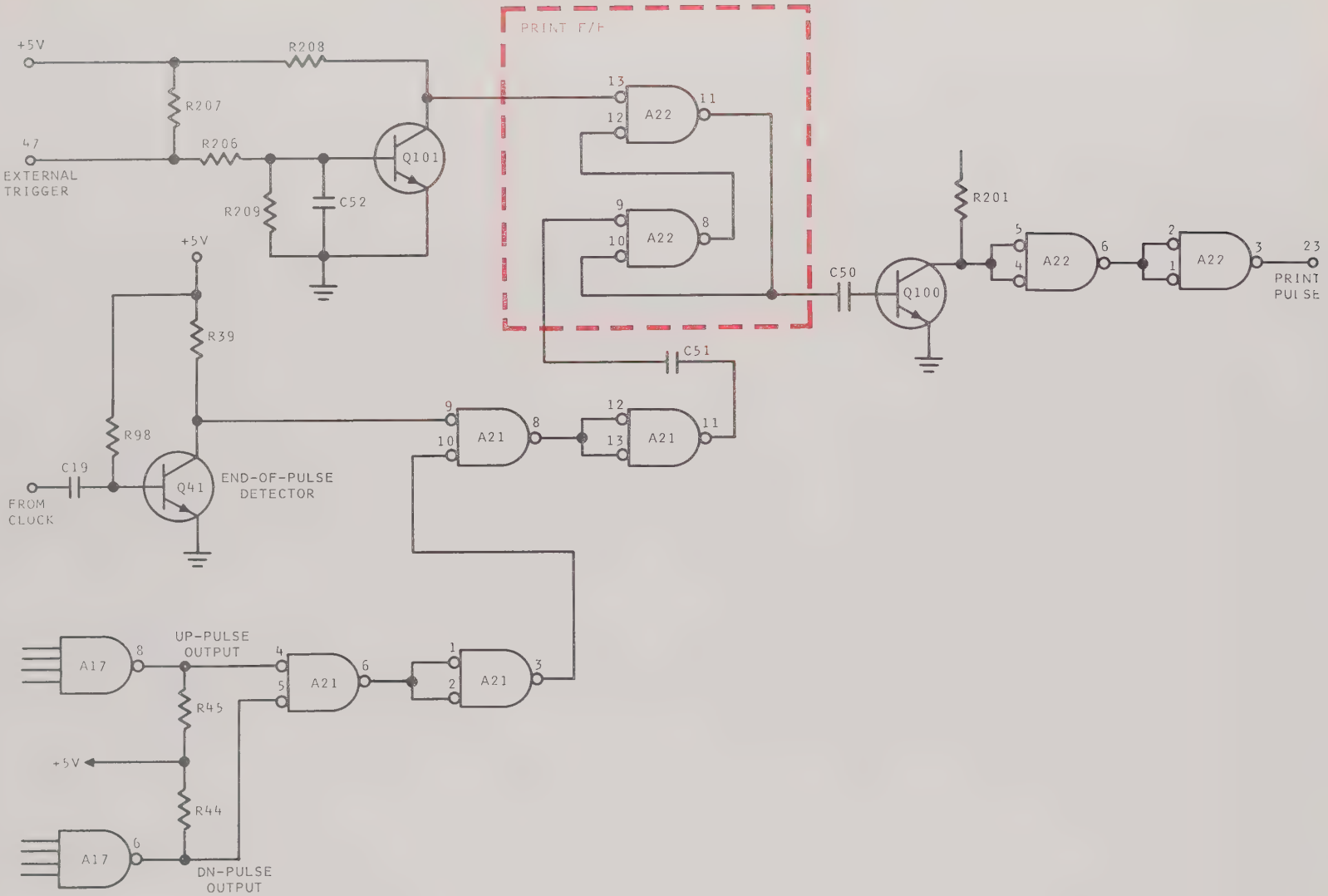



Figure 3-10. Simplified Diagram - External Trigger and Print Pulse Generator

section of A22 which feeds a second section similarly connected. Pin 3 of the second section is the output source of the print pulse at pin 33, J9.

## 3-38. RECHARGEABLE BATTERY OPTION

3-39. The LX-2 may be powered by the AC power line or by the optional rechargeable battery pack. The battery option uses a modified power supply which provides power for charging the battery pack and contains an inverter unit which provides ±17 volts and a 250V supply for the readout lamps.

3-40. CIRCUIT DESCRIPTION (Refer to Schematic Diagram 35-32)

3-41. Five-Volt Supply. Transformer D302 feeds full-wave rectifiers CR31-CR32. The rectified output is filtered by C40 thru C43 and is applied to the 5-volt regulator formed by Q30, Q31 and Q37. The regulated output appears at the collector of Q37 and is fed to the instrument. In the battery mode, the positive end of the battery is connected thru pin 19 of P1 which connects to J8, pin 19 and in turn to the input of the 5-volt regulator. CR31-CR32 block the DC path through the transformer.

3-42. Battery Charger Supply. Transformer D302 also supplies power for the battery charging circuits thru pins 17 and 18 of J8 which connects to pins 17 and 18 of P1. CR3-CR4 full-wave rectify the AC, applying DC to the battery thru current-limiting lamps V1 and V2. The battery pack charges automatically as long as the instrument is connected to the AC power line and the power switch is on.

3-43. When operating from the power line, Q7 actuates the battery disconnect relay (K1) which removes the battery as the 5-volt source, substituting the AC line-operated power supply discussed above. The battery disconnect circuit operates as follows: The presence of AC causes CR1 and C2 to provide a forward bias to Q7 which actuates relay K1, disconnecting the battery from the 5-volt line.

3-44. Battery Lo Lamp. Lamp DS2 (battery LO) indicates the condition of the battery pack. DS2 is actuated when differential pair Q9 and Q10 sense sufficient change in the battery output voltage as compared to the regulated 5-volt supply. The regulated five volts is applied to the base of Q10 while the battery output is sampled at the base of Q9 thru a resistive divider, R9 and R12. Unbalance in the inputs of Q9 and Q10 causes Q8 to turn on and illuminate DS2, indicating a drop in battery voltage.

3-45. Inverter. Transistors Q1 and Q2 have forward bias applied through R16. One transistor will differ from the other and so will conduct more heavily, allowing more current flow through the transistor and its primary winding. Current induced in the feedback winding cuts off the other transistor. This action continues until the transformer core saturates, causing the rate of charge of the magnetic flux to drop to zero, removing the base drive on the conducting, transistor. The current begins to decrease, reversing the magnetic flux causing base drive to appear on the other transistor, repeating the cycle in the other direction. Essentially, this action causes Q1 and Q2 to act as switches, effectively connecting the input power alternately across each half of the center-tapped primary winding, producing a 2KHz square wave power source. Secondary windings step up the battery voltage. The high voltage secondary is connected to pins 11 and 13 of P1 which connect to J8 and feed full-wave rectifier CR27 thru CR30.

After filtering by C36, 250 volts becomes available to drive the readout indicators. Another secondary winding feeds pins 15 and 16 with its center tap tied to pin 20. This additional winding provides power to CR23 and CR25, the -17-volt power supply and to CR24 and CR26, the +17-volt power supply.

# CHAPTER IV

# MAINTENANCE

## 4-1. INTRODUCTION

4-2. This chapter provides information pertaining to preventive and corrective maintenance for the Series LX-2 Digital Multifunction Meter. Preventive maintenance essentially consists of inspection of the instrument and components for damage or signs of overheating, and cleaning the instrument. This maintenance should be performed at 30-day intervals or as operating conditions permit. Corrective maintenance consists of performance tests, which are provided to assist in maintaining the instrument within its operating specifications, component replacement (tubes, lamps, etc.), calibration, and troubleshooting aids. Particular attention should be given to the Theory of Operation Chapter and the schematic diagrams in this manual prior to performing any troubleshooting, since a knowledge of the principles of operation of the instrument is of primary value in troubleshooting.

## 4-3. EQUIPMENT REQUIRED

4-4. The equipment recommended for performance testing, calibration and troubleshooting the instrument is listed below.

1. A DC Voltage Standard; John Fluke Model 332A, or equivalent.
2. An Ohms Standard; E.S.I. Model DB52, or equivalent.
3. An Audio Voltage Standard; Holt Model 631B, or equivalent.
4. An Oscilloscope; Tektronics Model 502, or equivalent.
5. A voltmeter; Triplett Model 630-NA, or equivalent.
6. A Variac, "Powerstat" Type 3PN, Superior Electric Co., or equivalent.
7. 1.5-Volt Flashlight Cell or 1.3-Volt Mercury Cell.

## 4-5. GENERAL MAINTENANCE

### 4-6. COMPONENT ACCESS

4-7. The following steps are provided to enable the user to disassemble the instrument in the easiest manner down to the point where further disassembly, if required, is obvious. It is not necessary to follow all of these steps to effect certain repairs or replacements. The following paragraphs of this chapter, pertaining to replacement of parts, calibration or troubleshooting, will refer to steps in this paragraph which are required to be taken prior to proceeding with replacement, calibration or troubleshooting. Reassemble in reverse order of disassembly as required.

NOTE

Although not necessary, it may prove more convenient to remove the handle while performing maintenance on the instrument. To do so, turn knobs counterclockwise until they can be removed from the chassis frame.

1. Remove top cover by removing two nylon screws at rear of instrument and lifting cover upward and back toward rear of instrument.
2. Remove top shield by removing four encircled screws. If battery option is included, a battery pack is located

on the underside of the shield with two wires connected to battery option printed circuit board located at rear of instrument.

**CAUTION**

Do not disconnect these two wires if instrument is operating or damage to components may result.

3. Remove Function Switching Assembly (Figure 4-1) by removing four attaching screws and disconnecting connectors P1 and P2 from Main Board Assembly.
4. To maintain circuit integrity and gain access to components located under the Function Switching Assembly, remove only the four screws and place the assembly upright in the slots provided (Figures 4-1 and 4-2).
5. If battery option is included, remove printed circuit board located at rear of instrument by removing four attaching screws and disconnecting connector P1 from Main Board Assembly.
6. Remove bottom cover by removing two nylon screws on bottom of instrument and lifting cover upward and back toward rear of instrument.
7. Remove bezel (Figure 4-3) by removing four attaching screws, lockwashers and nuts and pulling bezel away from front of instrument.
8. Remove bottom shield by removing four attaching screws.
9. Remove shield located on bottom of instrument under signal input connectors (Figure 4-4). by removing two

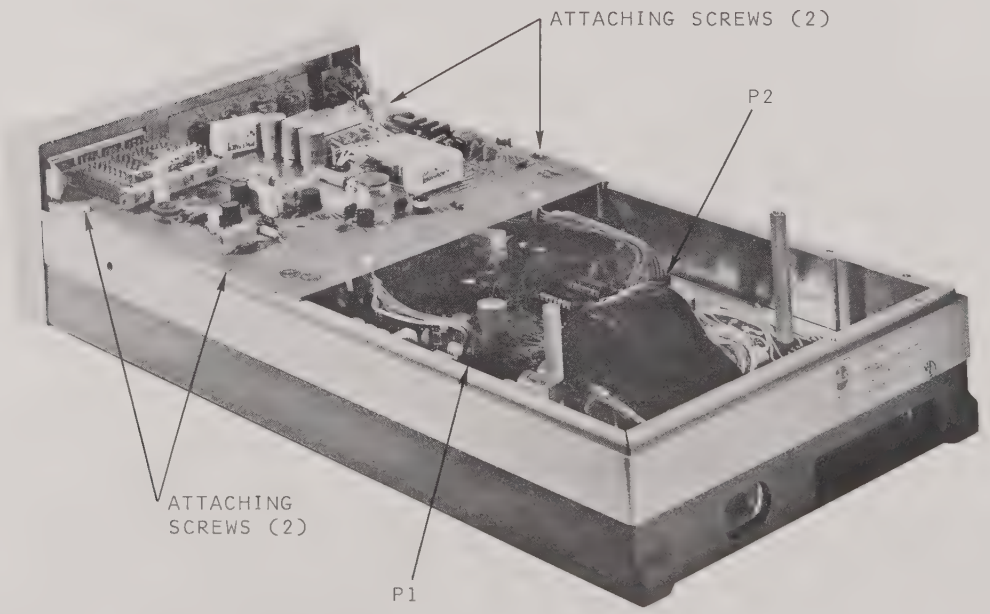



Figure 4-1. Function Switching Assembly Removal

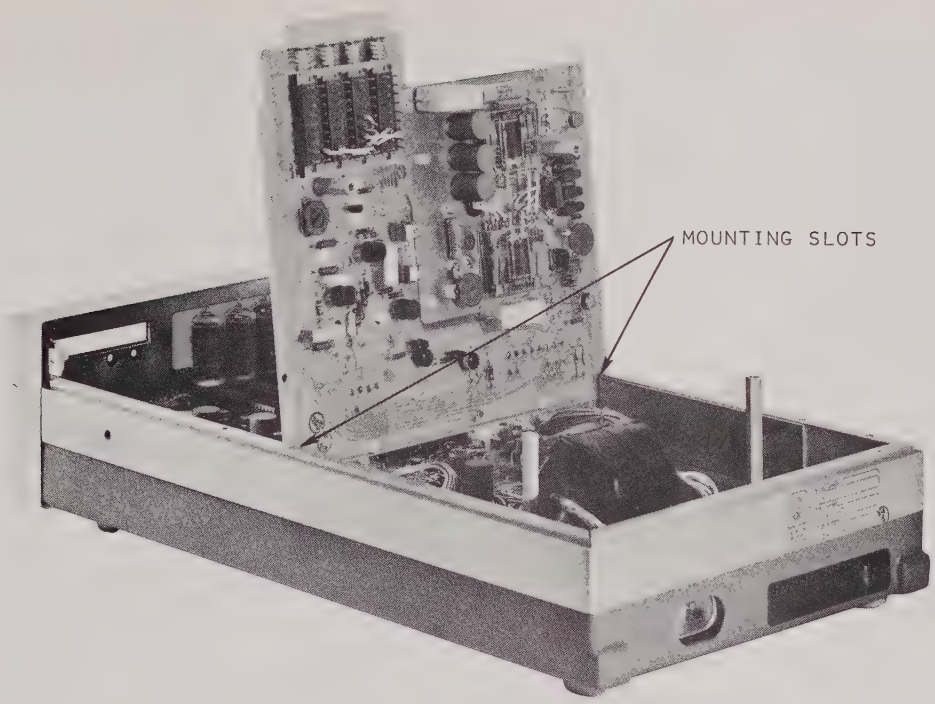



Figure 4-2. Partial Disassembly for Circuit Testing

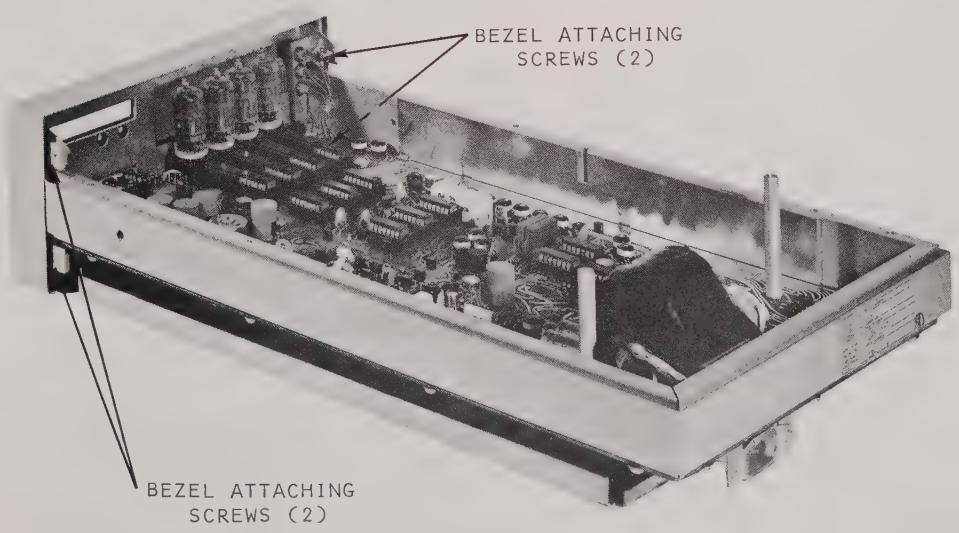



Figure 4-3. Bezel Removal

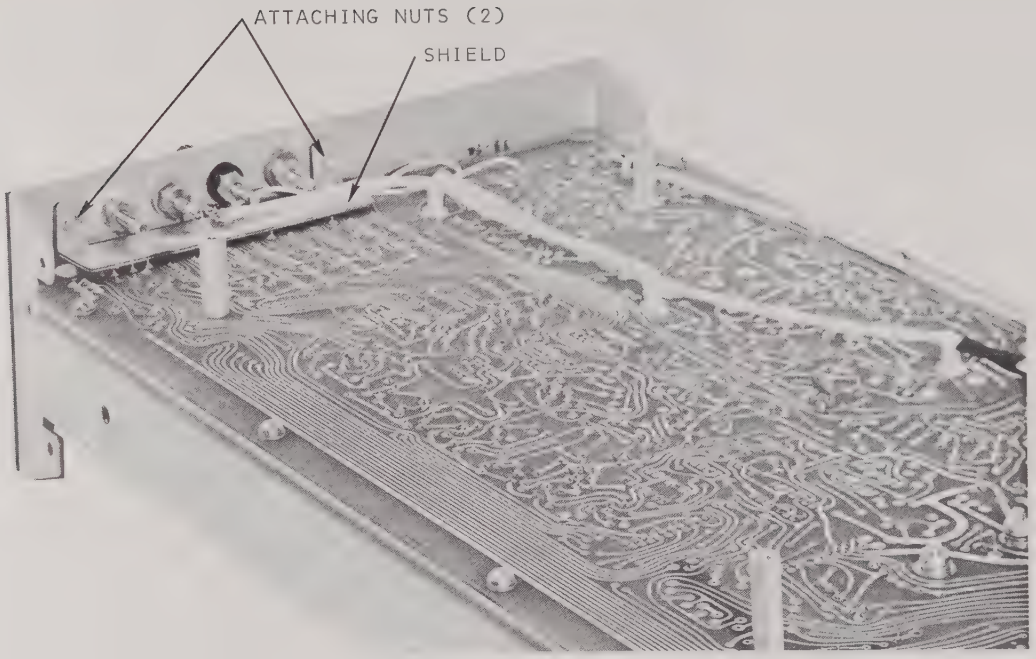



Figure 4-4. Readout Shield Removal

attaching nuts and lockwashers.

10. Remove polarity and battery low lamp bulb bracket from front plate by removing screw on side of instrument (Figure 4-5) and removing screw on bottom of instrument (Figure 4-6).

4-8. INSPECTION AND CLEANING

4-9. Perform steps 1, 2, 3, 5, 6 and 8 as set forth in paragraph 4-7. Inspect chassis, printed circuit boards and all mounted components for damage, signs of overheating, etc. Check front panel pushbutton switches for ease of operation.

4-10. Remove any accumulated dust with low-pressure, clean, dry air. Clean front panel and exterior surface with a soft cloth dampened with a mild solution of detergent and lukewarm water.

4-11. FUSE REPLACEMENT

4-12. Two fuses are located inside the instrument; if the battery option is included, a third fuse is provided. To gain access to fuses, perform steps 1 and 2 as set forth in paragraph 4-7. The line fuse (F1) is located on Main Board Assembly and is rated at one-half ampere (one-fourth ampere if instrument has been converted to 230-volt operation). The ohms circuit-protection fuse (F2) is located on Function Switching Assembly and is rated at one one-hundredth ampere. The battery line fuse (F3) is located on Battery Option printed circuit board and is rated at three amperes.

4-13. INTEGRATED CIRCUIT REPLACEMENT

4-14. The integrated circuit packages (A1 thru A17-also A21 and A22 if print option is

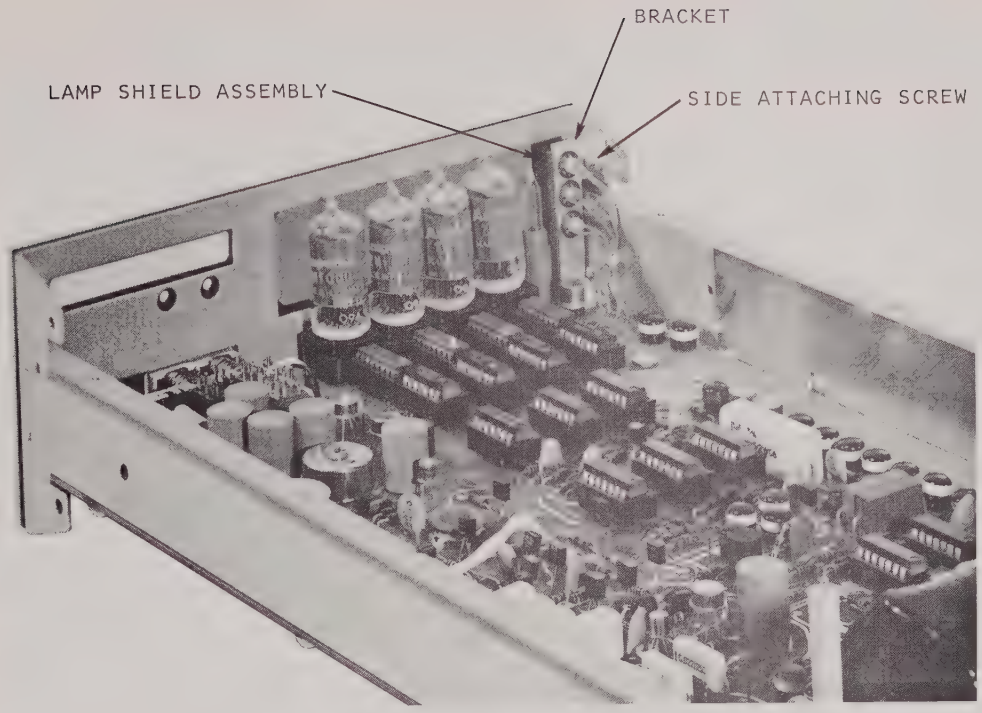



Figure 4-5. Lamp Bulb Bracket Removal

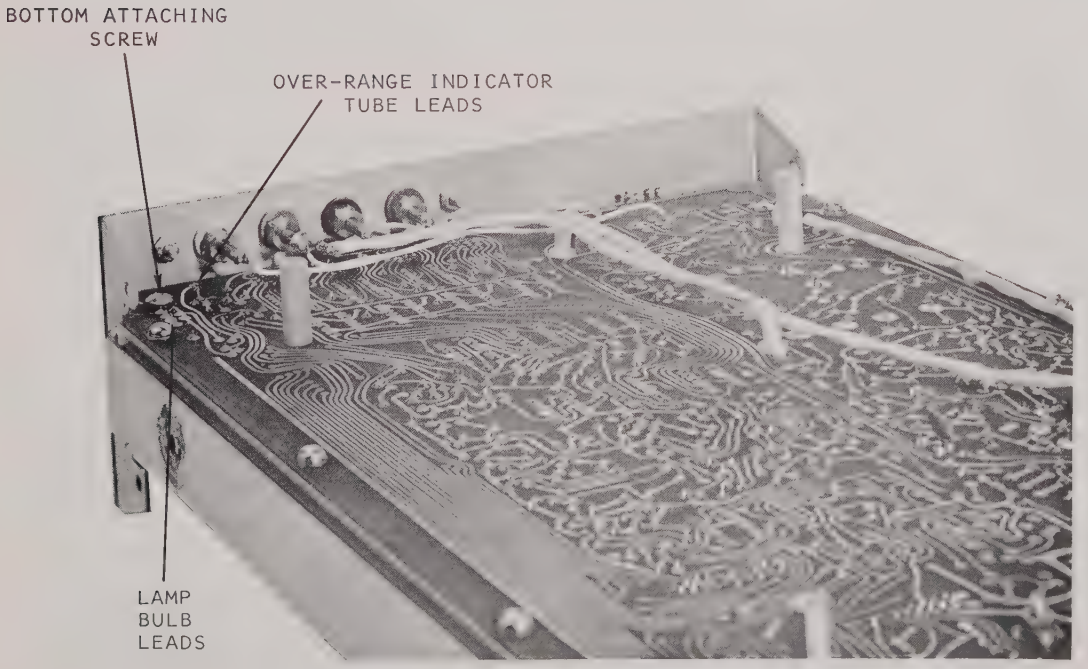



Figure 4-6. Lamp Bulb Bracket Removal and Component Leads

included) on the Main Board Assembly are mounted in sockets for ease of replacement. To replace any of these components, perform steps 1 thru 3 as set forth in paragraph 4-7. These components are properly installed when the keyed notch faces the rear of instrument except the readout drivers which are located directly behind the readout tubes - these must face the front.

4-15. READOUT TUBE REPLACEMENT

4-16. Access to the decimal, 0 thru 9-readout tubes may be gained by performing steps 1, 2, 3, 6 and 7 as set forth in paragraph 4-7. With a rocking motion, carefully pull faulty tube from its socket. Install new tube, using care to properly align pins into tube socket.

4-17. OVER-RANGE INDICATOR TUBE REPLACEMENT

4-18. The numeral "1" over-range indicator tube (DS1) leads are soldered to printed circuitry on the bottom of Main Board Assembly. Replace this tube as follows:

1. Perform steps 1 thru 3 and 6 thru 9 as as set forth in paragraph 4-7.
2. Unsolder tube leads at points indicated in Figure 4-6.
3. Solder leads of new tube into place, taking care to ensure a firm and clean solder connection.

4-19. POLARITY AND BATTERY LOW LAMP REPLACEMENT

4-20. The "+", "-" and BAT LO indicator lamps DS2, DS3 and DS4) leads are soldered to printed circuitry on the bottom of Main Board Assembly. Replace these lamps as follows:

1. Perform steps 1 thru 3 and 6 thru 10 as set forth in paragraph 4-7.
2. Pull lamp bulb bracket away from front plate and remove lamp shield assembly (Figure 4-5). Note that the shield assembly is installed so that the largest of the three recesses is placed at the bottom.
3. Remove retaining ring holding faulty bulb to bracket.
4. Remove faulty bulb from opening in bracket.
5. Unsolder leads of faulty bulb at point indicated in Figure 4-6.
6. Solder leads of new bulb into place, taking care to ensure a firm and clean solder connection.

4-21. BATTERY REPLACEMENT

4-22. If the battery option is installed, replace batteries as follows:

1. Perform steps 1 and 2 as set forth in paragraph 4-7.
2. Remove battery leads from pin plugs on Battery Option printed circuit board. Note that the black lead is connected to the pin nearest the fuse.
3. Remove six screws attaching the battery pack to the top shield.
4. Remove and replace batteries.

4-23. BALLAST LAMP REPLACEMENT

4-24. If battery option is installed, two ballast lamps are mounted on the Battery Option printed circuit board. Replace lamps as follows:

1. Perform steps 1, 2 and 5 as set forth in paragraph 4-7 and also perform step 2 as set forth in paragraph 4-22.

2. Unsolder lamp/s from bottom of printed circuit board.

3. Solder new lamp/s into place, taking care to ensure a firm and clean solder connection.

4-25. 115/230-VOLT CONVERSION

4-26. The instrument is normally shipped from the factory for operation from 115-volt, 50-400 Hz, single phase power sources. If shipped for other operation, the serial number tag at the rear of the instrument will indicate the correct power source. Conversion of the instrument from 115-volt operation to 230-volt operation may be accomplished as follows:

1. Perform steps 1, 2, 6 and 8 as set forth in paragraph 4-7.

2. Unsolder black and red/white transformer leads from bottom of Main Board Assembly.

3. Solder leads into unused overlapping pads adjacent to other transformer lead pads. Take care to ensure a firm and clean solder connection.

4. Replace one-half ampere fuse (F1) on Main Board Assembly with a one-fourth ampere fuse.

4-27. PERFORMANCE TESTS

4-28. The following performance tests are provided to verify that the performance of the instrument meets the specifications for accuracy set forth in Chapter I. The tests may be used as a receiving inspection procedure, for routine preventive maintenance and following overhaul, repair or calibration. The tests should be conducted under the following environmental conditions: ambient temperature 20° to 30°C and relative humidity of less than 70%. If the instrument cannot meet any of the performance tests, calibration or maintenance will be required.

4-29. INITIAL PREPARATION

1. Connect the instrument to the VAC power source.

2. Ensure that the shorting strap is between the LO terminal and GUARD terminal.

3. Switch instrument on by depressing POWER pushbutton. Allow a period of 30 minutes for instrument warm-up.

4. Press the FILTER pushbutton.

NOTE

Resistance of each lead should be less then 0.1Ω to avoid measurement error.

4-30. DC VOLTAGE TEST

1. Insert input leads into HI (red) and LO (black) connectors on front panel of instrument.

2. Press VDC pushbutton switch. If the EXT. REF. switch is in the "in" position, press it to bring it out to the non-operating position.

3. Connect leads together and adjust VDC zero potentiometer (located directly under VDC switch) until readout transfers from 0000 to +0001. Back off adjustment until readout transfers from 0000 to -0001. Now place the adjustment halfway between these settings to obtain a solid 0000.

4. Connect leads of instrument to voltage standard as shown in Figure 4-7.

5. Apply voltages shown in Table I; read-

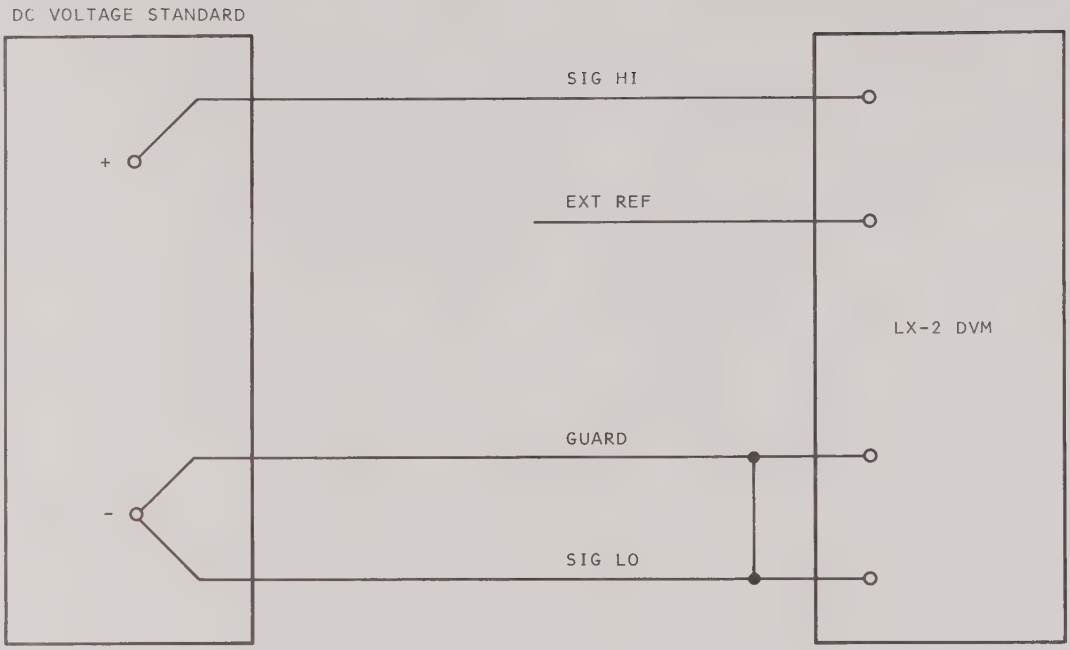



Figure 4-7. Connections for DC Voltage Measurement Test and Calibration

out should be within indicated limits.

Table I. DC Voltage Test

| VOLTAGE INPUT | RANGE | READOUT LIMITS |
|---|---|---|
| +1.1950 | 1 | +1.1947 to +1.1953 |
| +11.950 | 10 | +11.947 to +11.953 |
| +119.50 | 100 | +119.47 to +119.53 |
| + 950.0 | 1000 | + 949.7 to + 950.3 |

4-31. EXTERNAL REFERENCE TEST

1. Connect input leads of instrument to voltage standard as shown in Figure 4-8.
2. Press EXT. REF. pushbutton switch.
3. Apply voltage shown in Table II; readout should be within indicated limits.

Table II. External Reference Test

| REF. INPUT | VOLTAGE INPUT | READOUT LIMITS |
|---|---|---|
| +10.000 | +10.000 | + 9.997 to +10.003 |

4-32. RESISTANCE TEST

1. Connect input leads of instrument to ohms standard as shown in Figure 4-9.
2. Press KΩ pushbutton switch.
3. Apply ohmic values shown in Table III; readout should be within indicated limits.
4. Press $10^4$KΩ (10 MΩ) pushbutton.
5. Apply ohmic values shown in Table IV; readout should be within indicated limits.

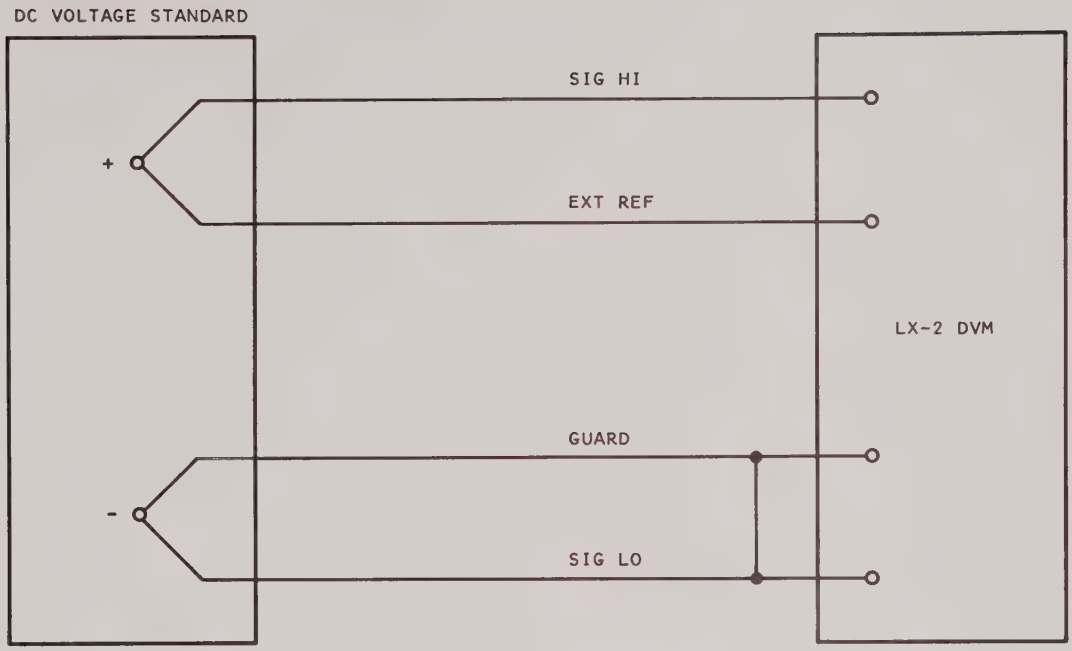



Figure 4-8. Connections for External Reference Measurement Test and Calibration

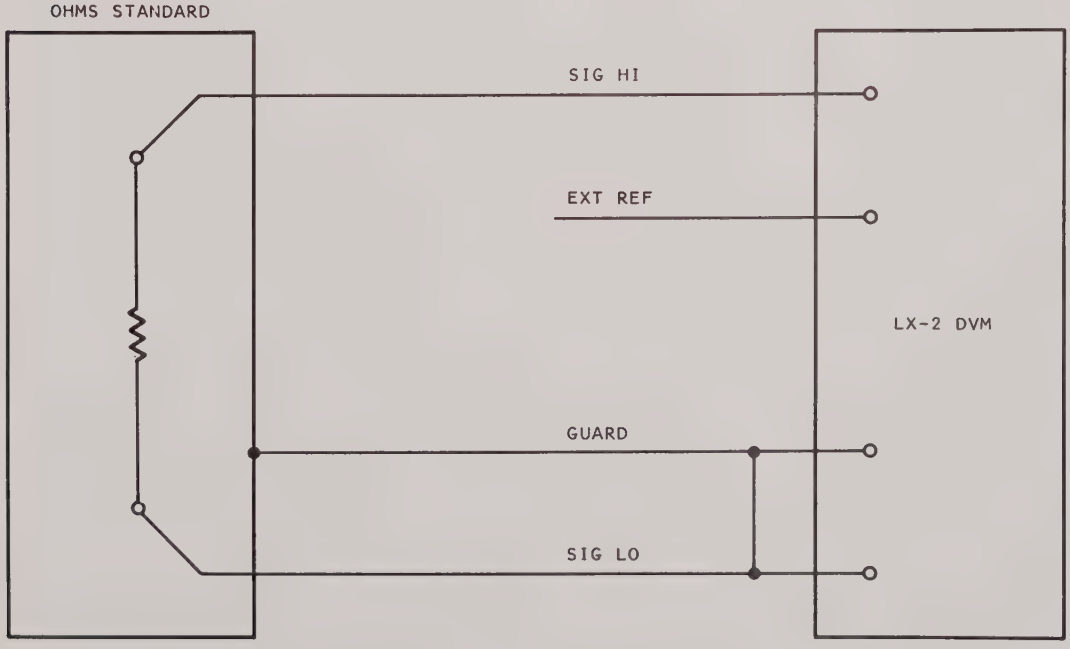



Figure 4-9. Connections for Resistance Measurement Test and Calibration

Table III. Resistance Test (KΩ)

| RESISTANCE INPUT | RANGE | READOUT LIMITS |
|---|---|---|
| 1.1950 KΩ | 1 | 1.1947 to 1.1953 |
| 11.950 KΩ | 10 | 11.947 to 11.953 |
| 119.59 KΩ | 100 | 119.47 to 119.53 |
| 1201.0 KΩ | 1000 | 1200.7 to 1201.3 |

Table IV. Resistance Test ($10^4$KΩ)

| RESISTANCE INPUT | RANGE | READOUT LIMITS |
|---|---|---|
| 12010 KΩ | $10^4$KΩ (10MΩ) | 12003 to 12017 |

4-33. AC VOLTAGE TEST

1. Press VAC pushbutton switch.
2. Connect signal Hi and signal Lo leads together and adjust VAC zero potentiometer (located directly under VAC switch) until readout transfers from 0000 to 0001. Back off adjustment until readout transfers from 0001 to 0000 and then to 0001. Now place the adjustment halfway between these settings to obtain a solid 0000.
3. Connect input leads of instrument to audio voltage standard as shown in Figure 4-10.
4. Apply voltages and frequency as shown in Table V; readout should be within indicated limits.

4-34. COMMON-MODE-REJECTION TEST

1. Press the VDC pushbutton switch.
2. Connect input leads of instrument to signal source (1.5-volt flashlight cell or 1.3-volt mercury cell) and common-mode source (a variac) as shown in Figure 4-11.
3. Set variac to zero volts then advance in voltage until a two-digit "bobble" is observed in the least significant decade. (A two-digit "bobble" occurs when the display "bobbles" between the true reading, the true reading plus one digit, and the true reading minus one digit. This corresponds to a superimposed noise of two digits peak-to-peak.) Now back off the variac until the two-digit "bobble" just stops leaving a one-digit "bobble". Measure the variac output with a volt meter and convert to peak-to peak voltage.
4. To obtain rejection ratio, divide the peak-to-peak common voltage by 200mv.

$$\text{Common-mode-rejection ratio} = \frac{E_{p-p}}{2 \times 10^{-4}}$$

$$DB = \frac{E_{p-p}}{2 \times 10^{-4}}$$

$$DB = 20 \log 5,000\ E_{p-p}$$

5. For example, if the common-mode voltage is 7V RMS

$$E_{p-p} = 7 \times 2.828$$

$$E_{p-p} = 20V \ \& \ DB = 20 \log 5,000 \times 20$$

$$DB = 2 - \log 10^5$$

$$DB = 20 \times 5 = 100$$

Common-Mode-Rejection = 100 DB

4-35. CALIBRATION

4-36. In these calibration instructions, it is assumed that the instrument is in good working order and only requires calibration. If any components are defective, it may be dif-

Table V. AC Voltage Test

| VOLTAGE INPUT @ 10K Hz | RANGE | READOUT LIMITS |
|---|---|---|
| 1.1950 | 1 | 1.1933 to 1.1967 |
| 11.950 | 10 | 11.933 to 11.967 |
| 119.50 | 100 | 119.33 to 119.67 |
| 950.0 | 1000 | 948.5 to 951.5 |

ficult, if not impossible, to calibrate the instrument.

4-37. INITIAL PREPARATION

1. Perform step 1 as set forth in paragraph 4-7.
2. Plug power cord into a 115 VAC (or 230 VAC if so wired) 50-400 Hz single phase power source, if desired; or utilize internal battery power source, if this option is included.
3. Press the pushbutton POWER switch and allow 30 minutes for instrument warm-up.

NOTE

It will be noted that access holes for adjustment points are provided and that they are labeled as to function and by sequence number (Figure 4-12. The STEPS in these calibration procedures correspond to the numbered STEPS adjacent to each access hole.

4-38. PROCEDURE

4-39. VDC Zero Adjustment

1. Insert input leads into the HI (red) and LO (black) connectors on the front panel of the instrument. Ensure that the shorting strap is connected

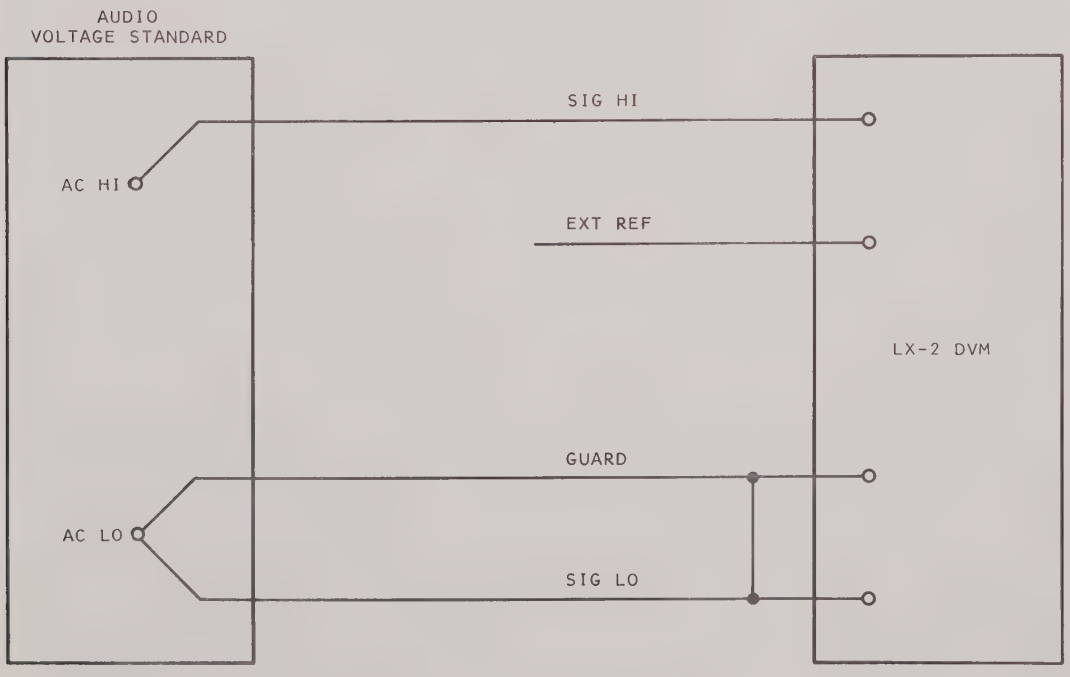



Figure 4-10. Connections for AC Voltage Measurement Test and Calibration

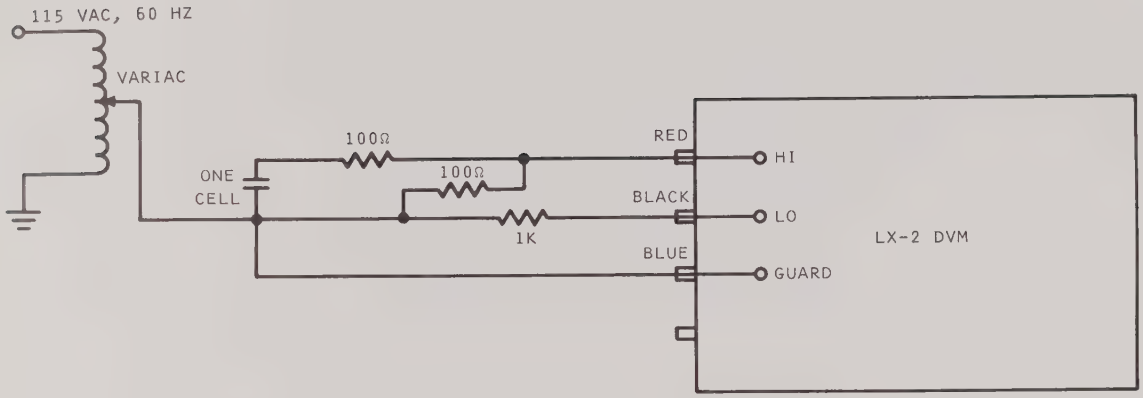



Figure 4-11. Connections for Common-Mode-Rejection Test

between the LO and GUARD connectors. Press the VDC and FILTER pushbutton switches. If the EXT. REF. switch is in the "in" position, press it to bring it out to the non-operating position.

2. Connect the leads together and adjust VDC Zero potentiometer, R6 - STEP NO. 1 - until the readout transfers from 0000 to +0001. Back off the adjustment until the readout transfers from 0000 to -0001. Now place the adjustment halfway between these settings to obtain a solid 0000.

4-40. Fast Detector Adjustment

1. Note the location of the Fast Detector potentiometer, R10 - STEP NO. 2.

2. Perform step 2 as set forth in paragraph 4-7 to gain access to Test Points 1 and 2. They are labeled TP1- and 2 and are located near the center of the Main Board Assembly at the rear of the Function Switching Assembly.

3. Using an oscilloscope, set sweep speed at 2 ms/cm and externally synchronize on the leading edge of pulse at TP2. Set vertical sensitivity to 2V/cm and display clock pulses at TP1. Apply +0. 0195 VDC to input of instrument (Figure 4-7). Rotate Fast Detector potentiometer, R10 - STEP NO. 2 - fully counterclockwise. A train of clock pulses should appear on the screen for 12. 5 ms. Rotate Fast Detector potentiometer clockwise until clock pulses just transfer to 8 ms duration. Verify the setting of the potentiometer by determining at what input voltage the clock pulses transfer from 12. 5 ms duration to 8 ms

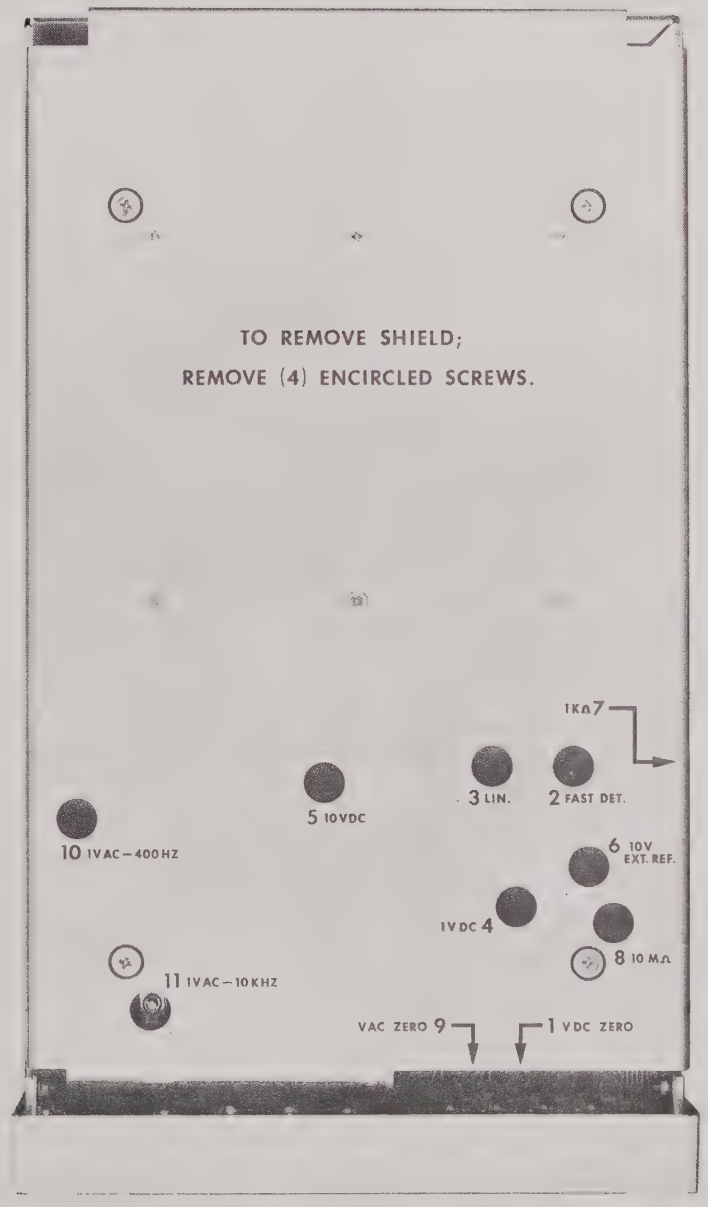



Figure 4-12. Location of Adjustment Points

duration. The setting is correct if this input lies within +0.0190 VDC and +0.0200 VDC.

4. Replace the shield.

4-41. Linearity Adjustment

1. Determine at what voltage the readout transfers from +.0184 VDC to +.0185 VDC (approximately +0.01846 VDC). Increase the input by +0.00200 VDC and adjust the Linearity potentiometer, R9 - STEP NO. 3 - until the readout transfers from +.0204 VDC to +.0205 VDC.

4-42. 1-VDC Range Adjustment

1. Connect the input leads of the instrument to the DC voltage standard as shown in Figure 4-7.
2. Apply 1.1950 volts and adjust potentiometer R8 - STEP NO. 4 - until the readout displays 1.1950.

4-43. 10-VDC Range Adjustment

1. Apply 11.950 volts and adjust potentiometer R3 - STEP NO. 4 - until the readout displays 11.950.
2. No adjustments are required for the upper two DC ranges, however they should be checked to ensure compliance with the specifications; i.e., apply 119.50 VDC and 950 VDC and check accuracy (should be within ±3 digits).

4-44. External Reference Adjustment

1. Connect the input leads of the instrument to the DC voltage standard as shown in Figure 4-8.
2. Press the EXT. REF. pushbutton switch.
3. Apply 10.000 volts and adjust potentiometer R7 - STEP NO. 6 - until the readout displays 10.000.
4. Press the EXT. REF. pushbutton switch to return it to the non-operating position.

4-45. 1-KΩ Range Adjustment

1. Press the KΩ pushbutton switch.
2. Connect the input leads of the instrument to the ohms standard as shown in Figure 4-9.
3. Apply 1.1950 KΩ and adjust potentiometer R4 - STEP NO. 7 - until the readout displays 1.1950.
4. No adjustments are required for the upper three KΩ ranges, however they should be checked to ensure compliance with specifications; i.e., apply 11.950 KΩ, 119.50 KΩ and 1195.0 KΩ and check accuracy (should be within ±3 digits).

4-46. $10^4$-KΩ Range Adjustment

1. Press the 10-MΩ ($10^4$-KΩ) pushbutton switch.
2. Apply 11950 KΩ and adjust potentiometer R2 - STEP NO. 8 - until the readout displays 11950.

4-47. VAC Zero Adjustment

1. Press the VAC pushbutton switch.
2. Connect the signal HI (red) and signal LO (black) input leads together and adjust VAC Zero potentiometer, R5 - STEP NO. 9 - until the readout trans-

fers from 0000 to 0001. Back off the adjustment until the readout transfers from 0001 to 0000 and then to 0001. Now place the adjustment halfway between these settings to obtain a solid 0000.

4-48. 1-VAC/400-Hz Range Adjustment

1. Connect the input leads of the instrument to the audio voltage standard as shown in Figure 4-10.
2. Apply 1.1950 VAC, 400 Hz and adjust potentiometer R1 - STEP NO. 10 - until the readout displays 1.1950.

4-49. 1-VAC/10K Hz Range Adjustment

1. Apply 1.1950 VAC, 10K Hz and adjust capacitor C1 - STEP NO. 11 - until the readout displays 1.1950,
2. No adjustments are required for the upper three VAC ranges, however they should be checked to ensure compliance with specifications; i.e., apply 11.950 VAC, 119.50 VAC and 950 VAC and check accuracy (should be within ±17 digits).

4-50. TROUBLESHOOTING

4-51. The following information is provided to assist in troubleshooting the instrument. Prior to checking internal voltages and observing waveforms to aid in isolation of the trouble, it should be definitely determined that the problem is actually in the instrument, not faulty AC line voltage or connection, faulty input connection or improper control settings. If these items are verified to be satisfactory and if the instrument fails to meet the performance tests and in addition cannot be calibrated, proceed with internal checking.

4-52. POWER SUPPLIES

4-53. In the following tests, the power supplies are checked with the voltmeter described in paragraph 4-4.

1. Perform steps 1, 2, and 4 as set forth in paragraph 4-7.
2. Connect instrument to AC line and press POWER pushbutton switch. Allow a period of 30 minutes for instrument warm-up.
3. Connect the voltmeter between GND (Figure 4-13) and circuit test locations on Main Board Assembly as set forth in Table VI. Voltmeter should read as indicated.

4-54. WAVEFORMS

4-55. In the following tests, waveform pattern are checked with the oscilloscope described in paragraph 4-4. Table VII provides test point locations, oscilloscope settings and reference to a figure which displays the proper pattern.

1. Perform steps 1, 2, and 4 as set forth in paragraph 4-7.
2. Connect instrument to AC line and press POWER pushbutton switch. Allow a period of 30 minutes for instrument warm-up.
3. Press VDC and FILTER pushbutton switches. Ensure that the EXT. REF pushbutton switch is in the "out" position.
4. Synchronize oscilloscope on the leading edge of pulse at TP2 (Index 9, Figure 4-13).
5. Connect instrument to voltage source

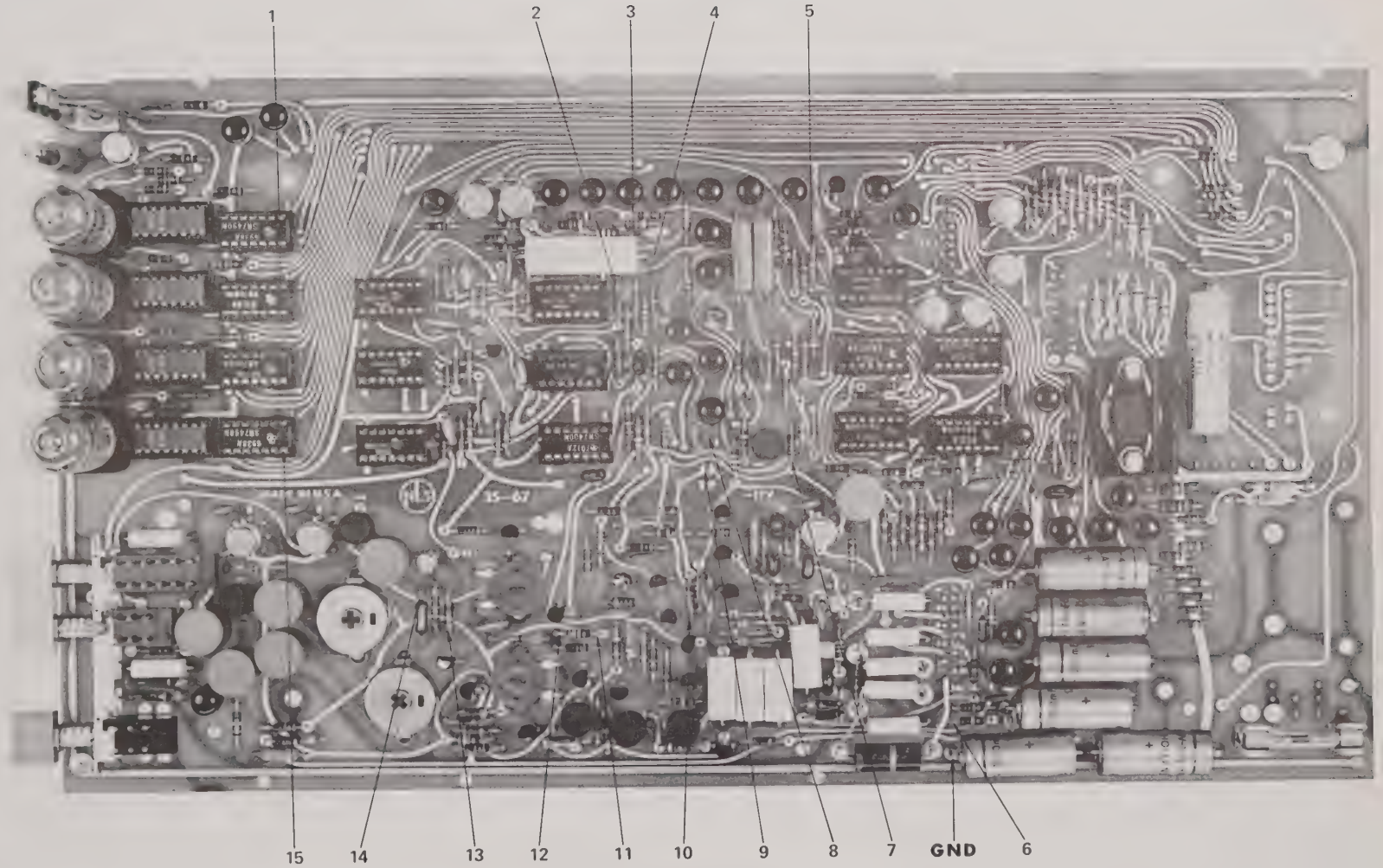



Figure 13. Main Board Assembly Circuit Test Locations

as shown in Figure 4-7 and apply 1.0278 volts.

6. Connect leads of oscilloscope to each of the test locations shown in Table VII and instrument GND (Figure 4-13). Compare waveform pattern displayed with the appropriate Figure indicated in the Table.

Table VI. Power Supply Voltage Tests

| VOLTAGE TEST LOCATION | | VOLTS DC | |
|---|---|---|---|
| | | NOMINAL | LIMITS |
| Figure | Index | | |
| 4-13 | 2 | +5 | +4.6 to +5.4 |
| 4-13 | 11 | +17 | +15.5 to +18.5 |
| 4-13 | 6 | -17 | -15.5 to -18.5 |

Table VII. Waveform Check with Test Locations and Oscilloscope Settings

| TEST LOCATION | | OSCILLOSCOPE | | PROPER PATTERN SHOWN IN FIGURE |
|---|---|---|---|---|
| | | VERTICAL SENSITIVITY | SWEEP SPEED | |
| Figure No. | Index | | | |
| 4-13 | 1 | 2V/cm | 2ms/cm | 4-14 |
| 4-13 | 3 | 2V/cm | 10ms/cm | 4-15 |
| 4-13 | 4 | 1V/cm | 0.1ms/cm | 4-16 |
| 4-13 | 5 | 2V/cm | 2ms/cm | 4-17 |
| 4-13 | 7 | 2V/cm | 2ms/cm | 4-18 |
| 4-13 | 8 | 2V/cm | 2ms/cm | 4-19 |
| 4-13 | 9 | 2V/cm | 1ms/cm | 4-20 |
| 4-13 | 10 | 2V/cm | 2ms/cm | 4-21 |
| 4-13 | 12 | 1V/cm | 2ms/cm | 4-22 |
| 4-13 | 13 | 5V/cm | 2ms/cm | 4-23 |
| 4-13 | 14 | 2V/cm | 2ms/cm | 4-24 |
| 4-13 | 15 | 2V/cm | 2ms/cm | 4-25 |
| 4-26 (Battery Option) | 16 | 5V/cm | 0.1ms/cm | 4-27 |

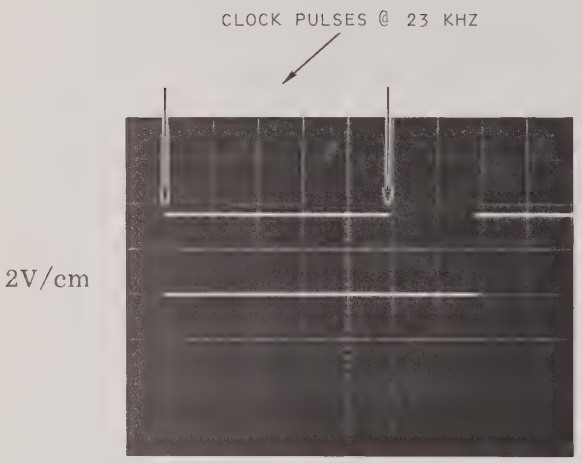



Figure 4-14. Waveform Pattern - Terminal 14 of A14 and GND

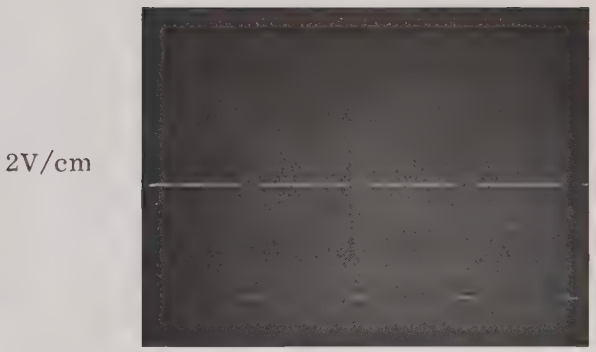



Figure 4-15. Waveform Pattern - Junction of R77 & Emitter of Q19, and GND

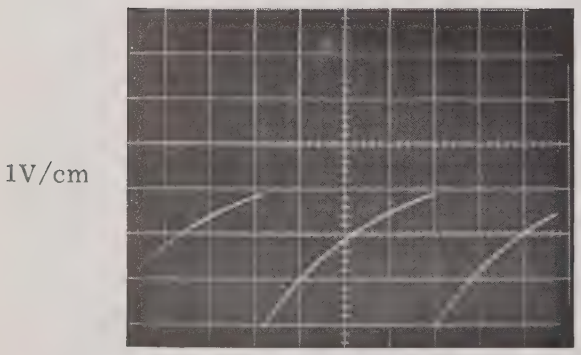



Figure 4-16. Waveform Pattern - Junction of R95 & R104, and GND

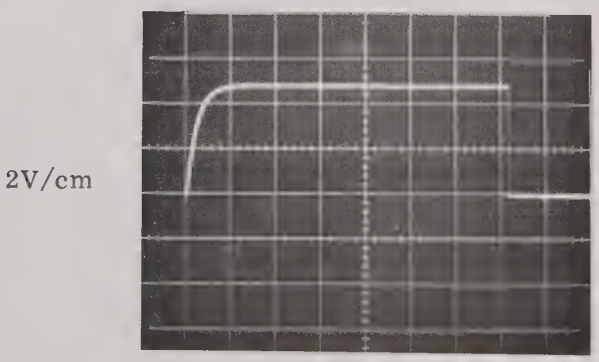
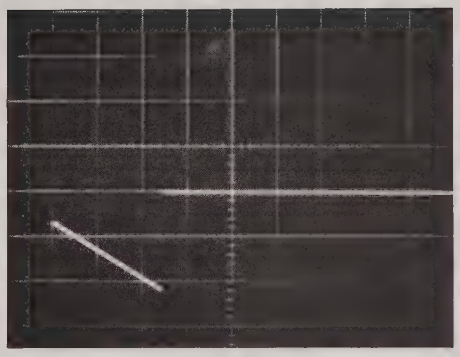


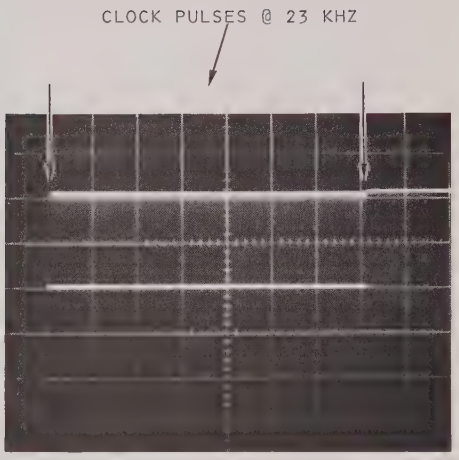

Figure 4-17. Waveform Pattern - Junction of R79 & C19, and GND



2V/cm

2ms/cm

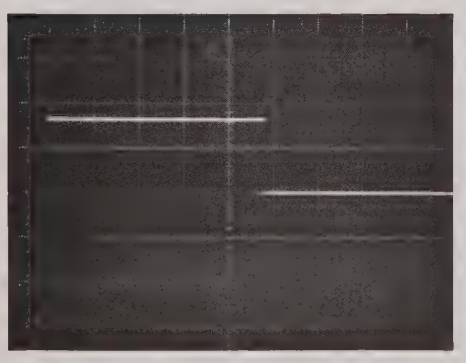
Figure 4-18. Waveform Pattern - Junction of R53 & CR13-CR14, and GND




2V/cm

2ms/cm

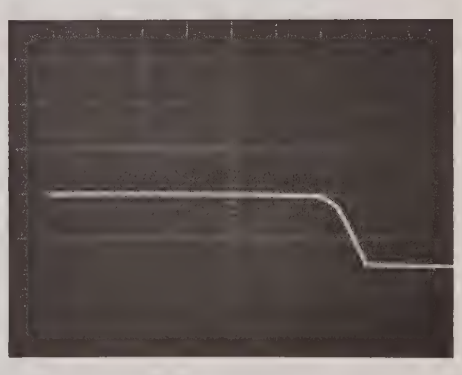
Figure 4-19. Waveform Pattern - TP1 and GND



2V/cm

1ms/cm

Figure 4-20. Waveform Pattern - TP2 and GND

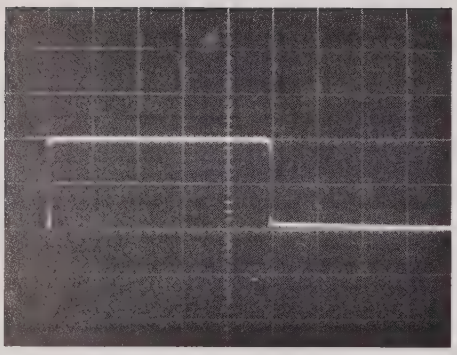


2V/cm

2ms/cm

Figure 4-21. Waveform Pattern - Junction of R110 & Collector of Q52, and GND

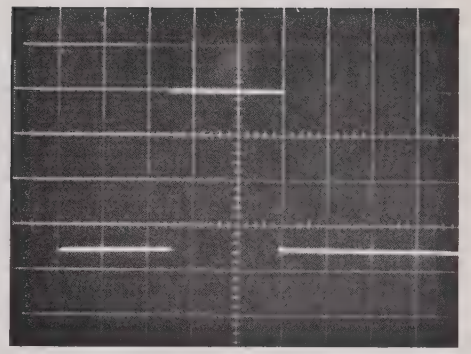
1V/cm



2ms/cm

Figure 4-22. Waveform Pattern - Junction of R112 & Base of Q50, and GND

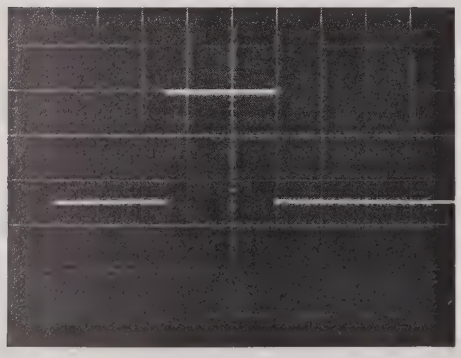
5V/cm



2ms/cm

Figure 4-23. Waveform Pattern - Junction of R50 & Collector of Q43, and GND

2V/cm

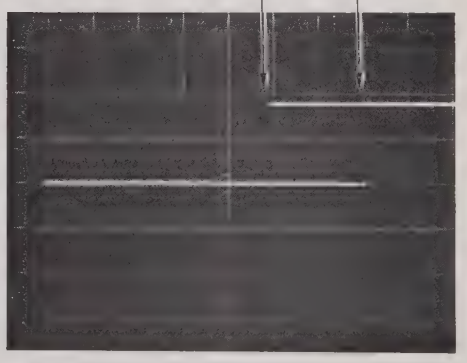


2ms/cm

Figure 4-24. Waveform Pattern - Junction of R147 & R152 and GND

CLOCK PULSES @ 23 KHZ

2V/cm



2ms/cm

Figure 4-25. Waveform Pattern - Terminal 14 of A16 and GND

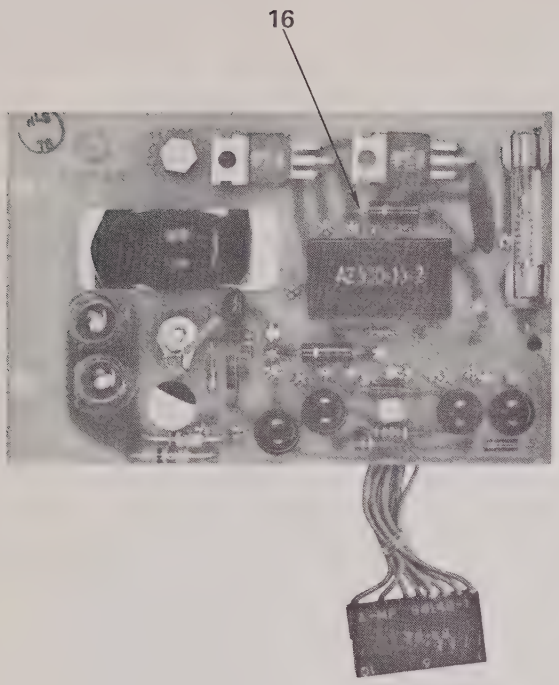



Figure 4-26. Battery Option Circuit Test Location

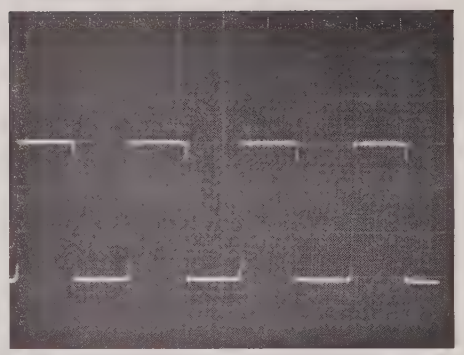



Figure 4-27. Waveform Pattern - Junction of R15 & Emitter of Q1,and GND

# CHAPTER V

## PARTS LIST

This chapter provides a list of electrical and electronic parts for the Series LX-2 Digital Multifunction Meter. The parts are listed alpha-numerically by reference designation in the REF DESIG column. The ZONE column lists the grid coordinates which locate the designated part on the accompanying illustration. Manufacturers of all components called out in the parts list are referred to by their Manufacturer's five-digit code number. Manufacturers and their codes are listed below.

| Code | Manufacturer |
|---|---|
| 00779 | Amp, Inc.<br>P. O. Box 3608<br>Harrisburg, PA |
| 01295 | Texas Instruments, Inc.<br>Transistor Products Division<br>Dallas, TX |
| 02660 | Amphenal-Borg Electronics Corp.<br>25th and Cermah<br>Maywood, IL |
| 03607 | Radio Corp. of America Commercial<br>Electronics Products Division<br>Los Angeles, CA |
| 03626 | Non-Linear Systems, Inc.<br>P. O. Box N<br>Del Mar, CA |
| 03730 | Gould Electric Co.<br>2621 W. Belmont<br>Chicago, IL |
| 03888 | Pyrofilm Resistor Co.<br>Morristown, NJ |
| 04713 | Motorola, Inc.<br>Semiconductor Products Division<br>5005 East Mc Dowell Road<br>Phoenix, AZ |
| 06751 | US Semiconductor Products Co., Inc.<br>Phoenix, AZ |
| 07263 | Fairchild Camera & Instrument Corp.<br>313 Bayshore Frontage Road<br>Mountain View, CA |
| 07910 | Continental Device Corp.<br>12515 Charden<br>Hawthorne, CA |
| 11237 | Chicago Telephone of Calif. Inc.<br>1010 Sycamore Avenue<br>South Pasadena, CA |
| 12040 | National Semiconductor Corp.<br>Danbury, CT |
| 12300 | Potter and Brumfield Canada, Ltd.<br>Guelph Ontario, Canada |
| 12406 | Elpac, Inc.<br>4270 Artesia<br>Fullerton, CA |
| 16170 | Amelco, Inc.<br>Los Angeles, CA |
| 18324 | Signetics Corp.<br>680 W. Maude Ave.<br>Sunnyvale, CA |

| Code | Manufacturer |
|---|---|
| 18722 | Radio Corporation of America<br>Industrial Tube and Semiconductor Division<br>Mountaintop, PA |
| 26806 | American Zettler, Inc.<br>697 Randolph Avenue<br>Costa Mesa, CA |
| 71590 | Centralab Division of Globe-Union, Inc.<br>932 East Keefe Avenue<br>Milwaukee, WI |
| 71744 | Chicago Miniature Lamp Works<br>4433 Ravenswood Avenue<br>Chicago, IL |
| 73445 | Amperex Electronics Co., Division of North American Philips Co., Inc.<br>Hicksville, NY |
| 75915 | Littlefuse, Inc.<br>800 E. Northwest Highway<br>Des Plaines, IL |
| 80053 | Panoramic Radio Products, Inc.<br>Mt. Vernon, NY |
| 80183 | Sprague Products<br>North Adams, MA |
| 82389 | Switchcraft, Inc.<br>5527 No. Elston Ave.<br>Chicago, IL |
| 82484 | Sprague Devices, Inc.<br>Huron & Frank Street<br>Michigan, IN |
| 84171 | Arco Electronics, Inc.<br>New York, NY |
| 91418 | Radio Materials Co.<br>4242 W. Bryn Mawr<br>Chicago, IL |

MAIN BOARD ASSEMBLY
(P/N 35-32)

with

PRINT OPTION ASSEMBLY
(P/N 35-56)

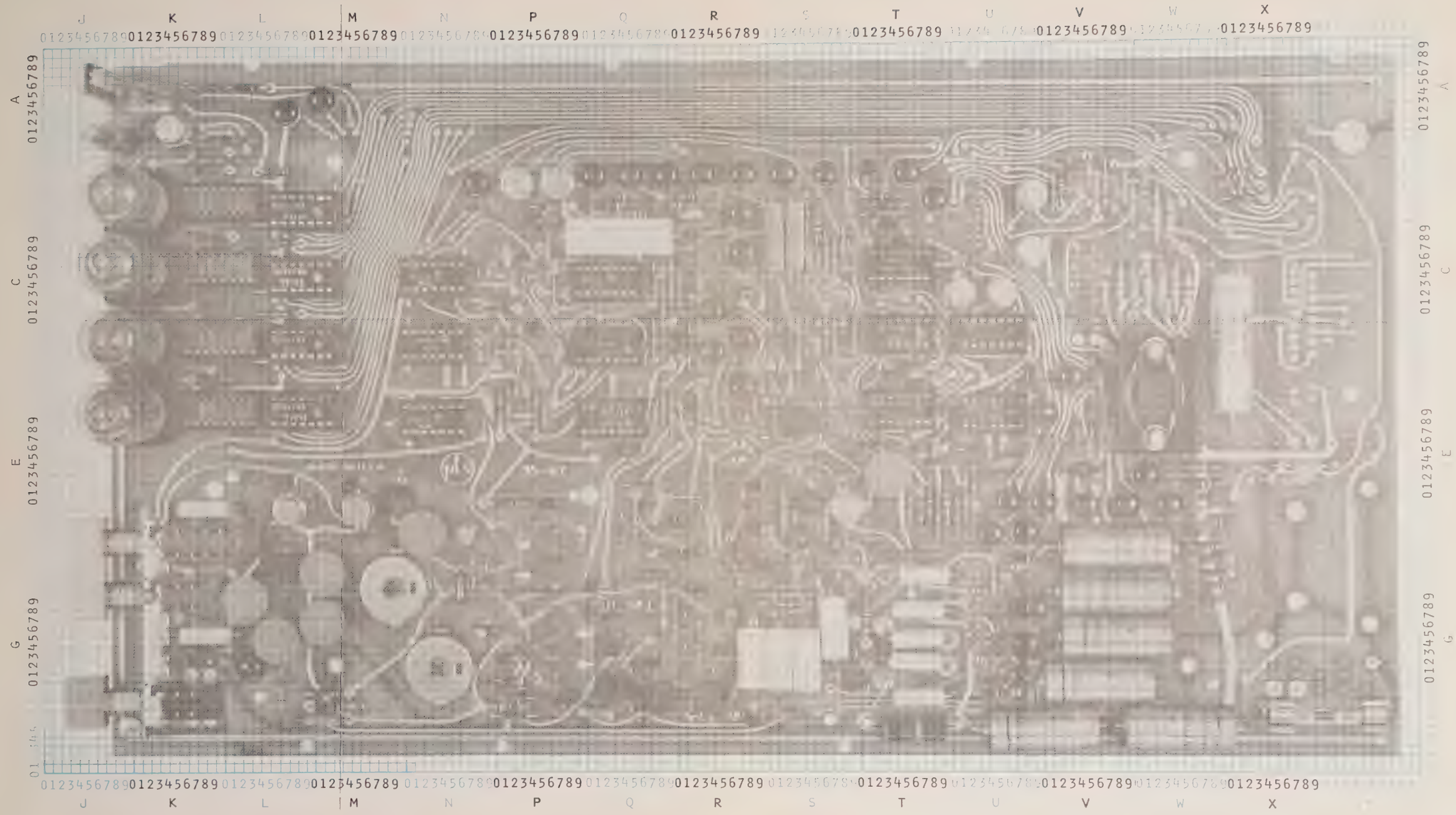


Figure 5-1. Main Board Assembly with Print Option Assembly

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1)

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| C5N3 | A1 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | 5 |
| E9N3 | A2 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | REF |
| D8U4 | A3 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | REF |
| C4Q2 | A4 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | REF |
| E9Q3 | A5 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | REF |
| D7N3 | A6 | SN7420N | Dual 4-Input Positive NAND Gate | 01295 | 1 |
| B3K9 | A7 | N7441B | Decoder/Driver | 18324 | 4 |
| C6K9 | A8 | N7441B | Decoder/Driver | 18324 | REF |
| D8K9 | A9 | N7441B | Decoder/Driver | 18324 | REF |
| D0K9 | A10 | N7441B | Decoder/Driver | 18324 | REF |
| D8T4 | A11 | SN7473N | Dual J-K Master Slave Flip-Flop | 01295 | 2 |
| D7Q2 | A12 | SN7473N | Dual J-K Master Slave Flip-Flop | 01295 | REF |
| B2L8 | A13 | SN7490N | Decade Counter | 01295 | 4 |
| C5L8 | A14 | SN7490N | Decade Counter | 01295 | REF |
| D7L8 | A15 | SN7490N | Decade Counter | 01295 | REF |
| D0L8 | A16 | SN7490N | Decade Counter | 01295 | REF |
| C6T4 | A17 | SN15830N | Dual 4-Input NAND/NOR Gate | 01295 | 1 |
| F9L7 | A18 | LM301A | Amplifier | 12040 | 3 |
| F9M5 | A19 | LM301A | Amplifier | 12040 | REF |
| F9S9 | A20 | LM301A | Amplifier | 12040 | REF |
| E2L5 | C1 | DD300 | Capacitor, 30 pF, 1 KV | 71590 | 3 |
| E2M1 | C2 | DD300 | Capacitor, 30 pF, 1 KV | 71590 | REF |
| D2P3 | C3 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | 6 |
| C7P1 | C4 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | REF |
| D1N9 | C5 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | REF |
| D7P7 | C6 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | REF |
| B1R2 | C7 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | REF |
| E2S8 | C8 | DD080 | Capacitor, 8 pF, 1 KV, 10% | 71590 | 1 |
| G9P4 | C9 | DD102 | Capacitor, 0.001 µF, 1 KV | 71590 | 1 |
| C9S3 | C10 | CM20E182F | Capacitor, 1800 pF, 500V, 1% | 84171 | 2 |
| C9S1 | C11 | CM20E182F | Capacitor, 1800 pF, 500V, 1% | 84171 | REF |
| F6R0 | C12 | 5002-010 | Capacitor, 0.002 µF, 500V, 20% | 03626 | 3 |
| H7Q1 | C13 | 5002-010 | Capacitor, 0.002 µF, 500V, 20% | 03626 | REF |
| G1U7 | C14 | 5002-010 | Capacitor, 0.002 µF, 500V, 20% | 03626 | REF |
| C4R2 | C15 | DDM103 | Capacitor, 0.01 µF, 150V, 10% | 91418 | 2 |
| F0S8 | C16 | DDM103 | Capacitor, 0.01 µF, 150V, 10% | 91418 | REF |
| G8T6 | C17 | C281AB/A10K | Capacitor, 0.01 µF, 250V, 10% | 73445 | 2 |
| H8T6 | C18 | C281AB/A10K | Capacitor, 0.01 µF, 250V, 10% | 73445 | REF |
| B2S9 | C19 | DDM203 | Capacitor, 0.02 µF, 150V, 10% | 91418 | 1 |
| F9K8 | C20 | C281AB/A22K | Capacitor, 0.022 µF, 250V, 10% | 73445 | 5 |
| F2T7 | C21 | C281AB/A22K | Capacitor, 0.022 µF, 250V, 10% | 73445 | REF |
| G5T6 | C22 | C281AB/A22K | Capacitor, 0.022 µF, 250V, 10% | 73445 | REF |
| G2T6 | C23 | C281AB/A22K | Capacitor, 0.022 µF, 250V, 10% | 73445 | REF |
| D7S2 | C24 | UK20-503 | Capacitor, 0.05 µF, 20V, 20% | 71590 | 1 |
| G2R8 | C25 | C281CH/A470K | Capacitor, 0.47 µF, 100V, 10% | 73445 | 4 |
| G2S1 | C26 | C281CH/A470K | Capacitor, 0.47 µF, 100V, 10% | 73445 | REF |
| G2S4 | C27 | C281CH/A470K | Capacitor, 0.47 µF, 100V, 10% | 73445 | REF |
| G6S7 | C28 | C281CH/A470K | Capacitor, 0.47 µF, 100V, 10% | 73445 | REF |
| C9Q3 | C29 | C281AB/B1M | Capacitor, 1 µF, 250V, 5% | 73445 | 1 |
| E5Q5 | C30 | TSD2-20-106 | Capacitor, 10 µF, 20V | 06751 | 4 |
| E0S4 | C31 | 5002-016 | Capacitor, 10 µF, 20V, 10% | 03626 | 2 |
| F5S7 | C32 | 5002-016 | Capacitor, 10 µF, 20V, 10% | 03626 | REF |

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| F6S3 | C33 | TSD2-20-106 | Capacitor, 10 μF, 20V | 06751 | REF |
| G3S9 | C34 | TSD2-20-106 | Capacitor, 10 μF, 20V | 06751 | REF |
| D7R0 | C35 | TSD2-20-106 | Capacitor, 10 μF, 20V | 06751 | REF |
| D7X1 | C36 | TVA1505 | Capacitor, 12 μF, 250V | 82484 | 1 |
| E3V4 | C37 | TSD3-6-476 | Capacitor, 47 μF, 6V | 06751 | 1 |
| F5V8 | C38 | ET471X025A01 | Capacitor, 470 μF, 25V | 73445 | 2 |
| G9V8 | C39 | ET471X025A01 | Capacitor, 470 μF, 25V | 73445 | REF |
| G5V8 | C40 | ET102X010P01 | Capacitor, 1000 μF, 10V | 73445 | 4 |
| G0V6 | C41 | ET102X010P01 | Capacitor, 1000 μF, 10V | 73445 | REF |
| H5V0 | C42 | ET102X010P01 | Capacitor, 1000 μF, 10V | 73445 | REF |
| H5W5 | C43 | ET102X010P01 | Capacitor, 1000 μF, 10V | 73445 | REF |
| G5K8 | C53 | C281AB/A22K | Capacitor, 0.022 μF, 250V, 10% | 73445 | REF |
| F1Q7 | C54 | JL150 | Capacitor, 150 pF, 1 KV, 10% | 91418 | REF |
| F2R6 | C55 | DD300 | Capacitor, 30 pF, 1 KV | 71590 | REF |
| C3P6 | CR1 | 5003-002 | Diode | 03626 | 9 |
| D8S1 | CR2 | 5003-002 | Diode | 03626 | REF |
| D3P2 | CR3 | 5003-002 | Diode | 03626 | REF |
| C5P0 | CR4 | 5003-002 | Diode | 03626 | REF |
| D7S3 | CR5 | 5003-002 | Diode | 03626 | REF |
| G8P6 | CR6 | 5003-002 | Diode | 03626 | REF |
| D0S6 | CR7 | 5003-002 | Diode | 03626 | REF |
| D0S8 | CR8 | 5003-002 | Diode | 03626 | REF |
| E0R1 | CR9 | 5003-005 | Diode | 03626 | 6 |
| F1R7 | CR10 | 5003-005 | Diode | 03626 | REF |
| F0S2 | CR11 | 5003-005 | Diode | 03626 | REF |
| G9S2 | CR12 | 5003-005 | Diode | 03626 | REF |
| G8S2 | CR13 | 5003-005 | Diode | 03626 | REF |
| G7S2 | CR14 | 5003-005 | Diode | 03626 | REF |
| G4K8 | CR15 | 1N458 | Diode | 04713 | 6 |
| G2K8 | CR16 | 1N458 | Diode | 04713 | REF |
| G0S9 | CR17 | 1N458 | Diode | 04713 | REF |
| H9S9 | CR18 | 1N458 | Diode | 04713 | REF |
| H7M2 | CR19 | See Note 1 | Diode (Matched with R151) | | 1 |
| F8L6 | CR20 | 1N914 | Diode | 07910 | 3 |
| F7P2 | CR21 | 1N914 | Diode | 07910 | REF |
| G7Q8 | CR22 | 1N914 | Diode | 07910 | REF |
| C3W1 | CR23 | 1N4005 | Diode | 04713 | 10 |
| C3V8 | CR24 | 1N4005 | Diode | 04713 | REF |
| C4W3 | CR25 | 1N4005 | Diode | 04713 | REF |
| C3W0 | CR26 | 1N4005 | Diode | 04713 | REF |
| B1W2 | CR27 | 1N4005 | Diode | 04713 | REF |
| B0W4 | CR28 | 1N4005 | Diode | 04713 | REF |
| C3W4 | CR29 | 1N4005 | Diode | 04713 | REF |
| C2W6 | CR30 | 1N4005 | Diode | 04713 | REF |
| E2X7 | CR31 | 1N4005 | Diode | 04713 | REF |
| E4X8 | CR32 | 1N4005 | Diode | 04713 | REF |
| F2W8 | CR33 | 1N5248B | Diode, Zener | 04713 | 2 |
| F3W8 | CR34 | 1N5248B | Diode, Zener | 04713 | REF |
| B7P6 | CR58 | 5003-002 | Diode | 03626 | REF |
| G9U6 | CR59 | 1N458 | Diode | 04713 | REF |
| G4U5 | CR60 | 1N458 | Diode | 04713 | REF |
| A1J5 | DS1 | 39-66 | Lamp, Indicator | 03626 | 1 |

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| A7J5 | DS2 | CM26-305 | Lamp, Indicator | 71744 | 3 |
| A7J3 | DS3 | CM26-305 | Lamp, Indicator | 71744 | REF |
| A7J4 | DS4 | CM26-305 | Lamp, Indicator | 71744 | REF |
| H6Y0 | F1 | 313.500 | Fuse, 3AG, 1/2A, Slo-Blo | 75915 | 1 |
| G0Y4 | J5 | AC3G | Receptacle, AC (Not shown) | 82389 | 1 |
| A1K4 | Q1 | 2N1893 | Transistor | 01295 | 5 |
| B5P7 | Q2 | 2N3440 | Transistor | 18722 | 1 |
| B4U9 | Q5 | 2N1893 | Transistor | 01295 | REF |
| C3U1 | Q6 | 2N1893 | Transistor | 01295 | REF |
| C3U6 | Q7 | 2N1893 | Transistor | 01295 | REF |
| C7U9 | Q8 | 2N1893 | Transistor | 01295 | REF |
| A4M1 | Q9 | 2N3569 | Transistor | 07263 | 23 |
| A3L6 | Q10 | 2N3569 | Transistor | 07263 | REF |
| B6S6 | Q11 | 2N3569 | Transistor | 07263 | REF |
| B6T5 | Q12 | 2N3569 | Transistor | 07263 | REF |
| B6S2 | Q13 | 2N3569 | Transistor | 07263 | REF |
| B6R7 | Q14 | 2N3569 | Transistor | 07263 | REF |
| B2R7 | Q15 | 2N3569 | Transistor | 07263 | REF |
| B6R3 | Q16 | 2N3569 | Transistor | 07263 | REF |
| B6Q1 | Q17 | 2N3569 | Transistor | 07263 | REF |
| B6Q5 | Q18 | 2N3569 | Transistor | 07263 | REF |
| B6Q9 | Q19 | 2N3569 | Transistor | 07263 | REF |
| C1R4 | Q20 | 2N3569 | Transistor | 07263 | REF |
| D8R7 | Q21 | 2N3569 | Transistor | 07263 | REF |
| G4U8 | Q22 | 2N3569 | Transistor | 07263 | REF |
| D7R4 | Q23 | 2N3569 | Transistor | 07263 | REF |
| B3T8 | Q24 | 2N3569 | Transistor | 07263 | REF |
| E0V0 | Q25 | 2N3569 | Transistor | 07263 | REF |
| F6U8 | Q26 | 2N3569 | Transistor | 07263 | REF |
| F6U4 | Q27 | 2N3569 | Transistor | 07263 | REF |
| E0U6 | Q28 | 2N3569 | Transistor | 07263 | REF |
| F9V5 | Q29 | 2N3569 | Transistor | 07263 | REF |
| F9W4 | Q30 | 2N3569 | Transistor | 07263 | REF |
| E3W1 | Q31 | 2N3569 | Transistor | 07263 | REF |
| C7R7 | Q32 | 2N3645 | Transistor | 07263 | 6 |
| D2R7 | Q33 | 2N3645 | Transistor | 07263 | REF |
| G2L3 | Q34 | 2N3645 | Transistor | 07263 | REF |
| G8U9 | Q35 | 2N3645 | Transistor | 07263 | REF |
| F9V9 | Q36 | 2N3645 | Transistor | 07263 | REF |
| D1W2 | Q37 | TIP32/2N3741 | Transistor | 01295 | 1 |
| F3R9 | Q38 | 2N3819 | Transistor | 01295 | 2 |
| F7R8 | Q39 | 2N3819 | Transistor | 01295 | REF |
| C3R7 | Q40 | 2N3904 | Transistor | 01295 | 11 |
| B6T1 | Q41 | 2N3904 | Transistor | 01295 | REF |
| D9P4 | Q42 | 2N3904 | Transistor | 01295 | REF |
| G4N8 | Q43 | 2N3904 | Transistor | 01295 | REF |
| E1R8 | Q44 | 2N3904 | Transistor | 01295 | REF |
| F4R1 | Q45 | 2N3904 | Transistor | 01295 | REF |
| F4Q7 | Q46 | 2N3904 | Transistor | 01295 | REF |
| H6R8 | Q47 | 2N3904 | Transistor | 01295 | REF |
| H8P7 | Q48 | 2N3904 | Transistor | 01295 | REF |
| G4Q3 | Q49 | 2N3904 | Transistor | 01295 | REF |

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| F0Q0 | Q50 | 2N3904 | Transistor | 01295 | REF |
| E0P6 | Q51 | 2N3906 | Transistor | 04713 | 6 |
| G7R4 | Q52 | 2N3906 | Transistor | 04713 | REF |
| G3R4 | Q53 | 2N3906 | Transistor | 04713 | REF |
| G2Q7 | Q54 | 2N3906 | Transistor | 04713 | REF |
| F0R2 | Q55 | 2N3906 | Transistor | 04713 | REF |
| G2P1 | Q56 | 2N3906 | Transistor | 04713 | REF |
| F1T0 | Q57 | 5003-015 | Transistor | 03626 | 1 |
| F6N6 | Q58 | 2N4977 | Transistor | 16170 | 1 |
| F2L6 | Q59 | TD101 | Transistor | 80183 | 4 |
| H8Q8 | Q60 | TD101 | Transistor | 80183 | REF |
| E9S3 | Q61 | TD101 | Transistor | 80183 | REF |
| E0M9 | Q62 | TD401 | Transistor | 80183 | 2 |
| H9Q3 | Q63 | TD401 | Transistor | 80183 | REF |
| B5N8 | Q102 | 2N3645 | Transistor | 07363 | REF |
| B5P2 | Q103 | 40527/40530 | Triac | 03607 | 1 |
| H8R4 | Q104 | TD101 | Transistor | 80183 | REF |
| A5L3 | R1 | RC07GF220J | Resistor, 22Ω, 1/4W, 5% | | 3 |
| G9W8 | R2 | RC07GF220J | Resistor, 22Ω, 1/4W, 5% | | REF |
| F6W6 | R3 | RC07GF220J | Resistor, 22Ω, 1/4W, 5% | | REF |
| D1R0 | R4 | RC07GF101J | Resistor, 100Ω, 1/4W, 5% | | 2 |
| F8S3 | R5 | RC07GF331J | Resistor, 330Ω, 1/4W, 5% | | 2 |
| F3S4 | R6 | RC07GF331J | Resistor, 330Ω, 1/4W, 5% | | REF |
| G2N4 | R7 | P115R101 | Potentiometer, 100Ω | 11237 | 1 |
| F0M8 | R8 | 5115R501 | Potentiometer, 500Ω | 11237 | 1 |
| F3P6 | R9 | U201R103B | Potentiometer, 10K | 11237 | 1 |
| G3P6 | R10 | U201R104B | Potentiometer, 100K | 11237 | 1 |
| D5T6 | R11 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | 3 |
| F0W8 | R12 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | REF |
| F5W7 | R13 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | REF |
| C8N9 | R14 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | 18 |
| C5P5 | R15 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| C6N8 | R16 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| C1P0 | R17 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| B2S4 | R18 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| D8S6 | R19 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| D8Q9 | R20 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E6T0 | R21 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E2U3 | R22 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E0U3 | R23 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E0T7 | R24 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| F8T9 | R25 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E0U0 | R26 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| F8U0 | R27 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E0T5 | R28 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| F8T6 | R29 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E2Q6 | R30 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| H8Q6 | R31 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| E2R3 | R32 | RC07GF392J | Resistor, 3.9K, 1/4W, 5% | | 1 |
| D0P5 | R33 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | 21 |
| E9P4 | R34 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D7P0 | R35 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| D6N9 | R36 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| C5P3 | R37 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D8S0 | R38 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| B0T3 | R39 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| E9N8 | R40 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| E9P0 | R41 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D8S7 | R42 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D4T4 | R44 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D3T6 | R45 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| C4Q9 | R46 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| C2Q8 | R47 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D7P8 | R48 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| C4Q7 | R49 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| F1N9 | R50 | RC07GF101J | Resistor, 100Ω, 1/4W, 5% | | REF |
| E0P1 | R51 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| G7Q3 | R52 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| E8S6 | R53 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D5S5 | R54 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| D0R2 | R55 | RC07GF752J | Resistor, 7.5K, 1/4W, 5% | | 1 |
| D1Q8 | R56 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | 13 |
| D8P1 | R57 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| C5P2 | R58 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| A0L1 | R59 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| B6L6 | R60 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| D0P1 | R61 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| C5P8 | R62 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| D7R1 | R63 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| G7K8 | R64 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| F1N7 | R65 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| F8R0 | R66 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| G7Q7 | R67 | RC07GF302J | Resistor, 3K, 1/4W, 5% | | 1 |
| H6P2 | R68 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| E0W8 | R69 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| B6K8 | R70 | RC07GF153J | Resistor, 15K, 1/4W, 5% | | 4 |
| C9K9 | R71 | RC07GF153J | Resistor, 15K, 1/4W, 5% | | REF |
| C1K9 | R72 | RC07GF153J | Resistor, 15K, 1/4W, 5% | | REF |
| D3K9 | R73 | RC07GF153J | Resistor, 15K, 1/4W, 5% | | REF |
| F0U7 | R74 | RC07GF113J | Resistor, 11K, 1/4W, 5% | | 2 |
| G0U5 | R75 | RC07GF113J | Resistor, 11K, 1/4W, 5% | | REF |
| C4S4 | R76 | RC07GF183J | Resistor, 18K, 1/4W, 5% | | 3 |
| B3R1 | R77 | RC07GF183J | Resistor, 18K, 1/4W, 5% | | REF |
| F9R8 | R78 | RC07GF183J | Resistor, 18K, 1/4W, 5% | | REF |
| C8S8 | R79 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | 13 |
| B1T2 | R80 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B4X1 | R81 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B6X1 | R82 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B3X2 | R83 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B9X1 | R84 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B2T3 | R85 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B3T2 | R86 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| D8Q7 | R87 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| G6R1 | R88 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |

MAIN BOARD ASSEMBLY, P/N 35-32 (Figure 5-1) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| F6Q4 | R89 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B7L0 | R90 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | 8 |
| C8L6 | R91 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| C0L6 | R92 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| D4L1 | R93 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| C6R5 | R94 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| C3R0 | R95 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| F8Q5 | R96 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| B1Q6 | R97 | RC07GF393J | Resistor, 39K, 1/4W, 5% | | 1 |
| C9T2 | R98 | RC07GF473J | Resistor, 47K, 1/4W, 5% | | 1 |
| H9M1 | R99 | RC07GF513J | Resistor, 51K, 1/4W, 5% | | 2 |
| C7S7 | R100 | RC07GF753J | Resistor, 75K, 1/4W, 5% | | 2 |
| D8S4 | R101 | RC07GF753J | Resistor, 75K, 1/4W, 5% | | REF |
| B8K8 | R102 | RC07GF513J | Resistor, 51K, 1/4W, 5% | | REF |
| E9Q9 | R103 | RC07GF104J | Resistor, 100K, 1/4W, 5% | | 3 |
| C4R1 | R104 | RC07GF104J | Resistor, 100K, 1/4W, 5% | | REF |
| E9S1 | R105 | RC07GF104J | Resistor, 100K, 1/4W, 5% | | REF |
| H9L6 | R106 | RC07GF124J | Resistor, 120K, 1/4W, 5% | | 1 |
| F3U8 | R107 | RC07GF154J | Resistor, 150K, 1/4W, 5% | | 2 |
| H9U5 | R108 | RC07GF154J | Resistor, 150K, 1/4W, 5% | | REF |
| E7S0 | R109 | RC07GF184J | Resistor, 180K, 1/4W, 5% | | 1 |
| F2R5 | R110 | RC07GF244J | Resistor, 240K, 1/4W, 5% | | 2 |
| F3R6 | R111 | RC07GF244J | Resistor, 240K, 1/4W, 5% | | REF |
| G8Q3 | R112 | RC07GF394J | Resistor, 390K, 1/4W, 5% | | 2 |
| H6R4 | R113 | RC07GF914J | Resistor, 910K, 1/4W, 5% | | 1 |
| H7P1 | R114 | RC07GF394J | Resistor, 390K, 1/4W, 5% | | REF |
| F2Q8 | R115 | RC07GF514J | Resistor, 510K, 1/4W, 5% | | 1 |
| F9R2 | R116 | RC07GF754J | Resistor, 750K, 1/4W, 5% | | 2 |
| C6S6 | R117 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | 6 |
| H7S2 | R120 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | REF |
| H9P1 | R121 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | REF |
| H9Q5 | R122 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | REF |
| G9T2 | R123 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | REF |
| G3T2 | R124 | RC07GF105J | Resistor, 1M, 1/4W, 5% | | REF |
| G5R2 | R125 | RC07GF155J | Resistor, 1.5M, 1/4W, 5% | | 2 |
| G6R0 | R126 | RC07GF155J | Resistor, 1.5M, 1/4W, 5% | | REF |
| G0P2 | R127 | RC07GF205J | Resistor, 2M, 1/4W, 5% | | 2 |
| F2S6 | R128 | RC07GF305J | Resistor, 3M, 1/4W, 5% | | 1 |
| H8P2 | R129 | RC07GF515J | Resistor, 5.1M, 1/4W, 5% | | 1 |
| F1T4 | R130 | RC07GF106J | Resistor, 10M, 1/4W, 5% | | 1 |
| F9W8 | R131 | RL07S332G | Resistor, 3.3K, 1/4W, 2% | | 1 |
| F7W8 | R132 | RL07S133G | Resistor, 13K, 1/4W, 2% | | 1 |
| C0S8 | R133 | RL07S153G | Resistor, 15K, 1/4W, 2% | | 3 |
| B2Q9 | R134 | RL07S153G | Resistor, 15K, 1/4W, 2% | | REF |
| B3Q3 | R135 | RL07S153G | Resistor, 15K, 1/4W, 2% | | REF |
| B0S5 | R136 | RL07S243G | Resistor, 24K, 1/4W, 2% | | 1 |
| F7T2 | R137 | RL07S303G | Resistor, 30K, 1/4W, 2% | | 2 |
| F8S5 | R138 | RL07S303G | Resistor, 30K, 1/4W, 2% | | REF |
| G6T1 | R139 | RL07S473G | Resistor, 47K, 1/4W, 2% | | 1 |
| B2Q2 | R140 | RL07S753G | Resistor, 75K, 1/4W, 2% | | 1 |
| E2W7 | R141 | RC20GF101J | Resistor, 100Ω, 1/2W, 5% | | 2 |
| E3W7 | R142 | RC20GF101J | Resistor, 100Ω, 1/2W, 5% | | REF |

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| C7W7 | R143 | RC07GF205J | Resistor, 2M, 1/4W, 5% | | REF |
| H5T6 | R145 | RC42GF105J | Resistor, 1M, 2W, 5% | | 1 |
| H6M1 | R146 | RN60C3571F | Resistor, 3.57K, 1/8W, 1% | | 1 |
| F0N6 | R147 | RN60C4023B | Resistor, 402K, 1/8W, 0.1% | | 1 |
| F9S1 | R148 | RN60D2004F | Resistor, 2M, 1/2W, 1% | | 2 |
| F4T6 | R149 | RN60D2004F | Resistor, 2M, 1/2W, 1% | | REF |
| E3T3 | R150 | PW1620812R0M | Resistor, 812Ω, 0.05% | 03626 | 1 |
| F7M1 | R151 | See Note 1 | Resistor, (Matched with CR19) | | 1 |
| F6N2 | R152 | PW162040600M | Resistor, 4.06K, 0.05% | 03626 | 1 |
| G5L5 | R153 | PW162049500M | Resistor, 4.95K, 0.05% | 03626 | 1 |
| G9L2 | R154 | PW162010001M | Resistor, 10K, 0.05% | 03626 | 1 |
| F2M1 | R155 | PW162020001M | Resistor, 20K, 0.05% | 03626 | 1 |
| B4R5 | R215 | RC07GF333J | Resistor, 33K, 1/4W, 5% | | REF |
| B2P6 | R216 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B2N8 | R217 | RC07GF201J | Resistor, 200Ω, 1/4W, 5% | | REF |
| B1P4 | R218 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| B0P5 | R219 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| G1R4 | R220 | RC07GF754J | Resistor, 750K, 1/4W, 5% | | REF |
| D3S3 | R221 | RC07GF201J | Resistor, 200Ω, 1/4W, 5% | | REF |
| F4K7 | S1 | 35-40 | Switch Assembly, Filter | 03626 | 1 |
| F0K6 | S2 | 35-41 | Switch Assembly | 03626 | 2 |
| H8K6 | S3 | 35-41 | Switch Assembly | 03626 | REF |
| F3X9 | T1 | D304 | Transformer (Not Shown) - If Battery Option Assembly is included, P/N is D302 | 03626 | 1 |
| D0J7 | V1 | ZM1000 | Tube, Indicator | 73445 | 4 |
| D8J7 | V2 | ZM1000 | Tube, Indicator | 73445 | REF |
| C7J7 | V3 | ZM1000 | Tube, Indicator | 73445 | REF |
| B4J7 | V4 | ZM1000 | Tube, Indicator | 73445 | REF |

NOTE

(1) Diode CR19 and Resistor R151 are a matched set and must be replaced as a matched set. Order by NLS part number 35-43.

PRINT OPTION ASSEMBLY, P/N 35-56 (Figure 5-1)

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| D0T4 | A21 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | 2 |
| E9U4 | A22 | SN7400N | Quadruple 2-Input Positive NAND Gate | 01295 | REF |
| E4U6 | C50 | DDM203 | Capacitor, 0.02 μF, 150V | 91418 | 1 |
| D3U9 | C51 | DDM103 | Capacitor, 0.01 μF, 150V | 91418 | 2 |
| D3V6 | C52 | DDM103 | Capacitor, 0.01 μF, 150V | 91418 | REF |
| B4T1 | C56 | JL470 | Capacitor, 470 pF, 1 KV, 10% (Reverse side) | 91418 | 1 |
| B4W1 | CR50 | 5003-002 | Diode | 03626 | 8 |
| B3V8 | CR51 | 5003-002 | Diode | 03626 | REF |
| B4V6 | CR52 | 5003-002 | Diode | 03626 | REF |
| B4V9 | CR53 | 5003-002 | Diode | 03626 | REF |
| B5V5 | CR54 | 5003-002 | Diode | 03626 | REF |
| B4V7 | CR55 | 5003-002 | Diode | 03626 | REF |
| B3W0 | CR56 | 5003-002 | Diode | 03626 | REF |
| B4V4 | CR57 | 5003-002 | Diode | 03626 | REF |
| C9Y5 | J9 | 57-40500 | Connector (Not shown) | 02660 | 1 |
| E9V1 | Q100 | 2N3569 | Transistor | 07263 | 2 |
| D4V3 | Q101 | 2N3569 | Transistor | 07263 | REF |
| C8T5 | R200 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | 4 |
| E6V1 | R201 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| E5V0 | R202 | RC07GF473J | Resistor, 47K, 1/4W, 5% | | 1 |
| E5T6 | R203 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | 2 |
| E4T9 | R204 | RC07GF202J | Resistor, 2K, 1/4W, 5% | | REF |
| D3U8 | R205 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| E7V5 | R206 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | 3 |
| E7V4 | R207 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| E5U3 | R208 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | 4 |
| D3V5 | R209 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | REF |
| E6U0 | R210 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | REF |
| B4V1 | R211 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B5V2 | R212 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |
| B5V3 | R213 | RC07GF203J | Resistor, 20K, 1/4W, 5% | | REF |

FUNCTION SWITCHING ASSEMBLY
(P/N 35-24)

with

BATTERY OPTION ASSEMBLY
(P/N 35-47)

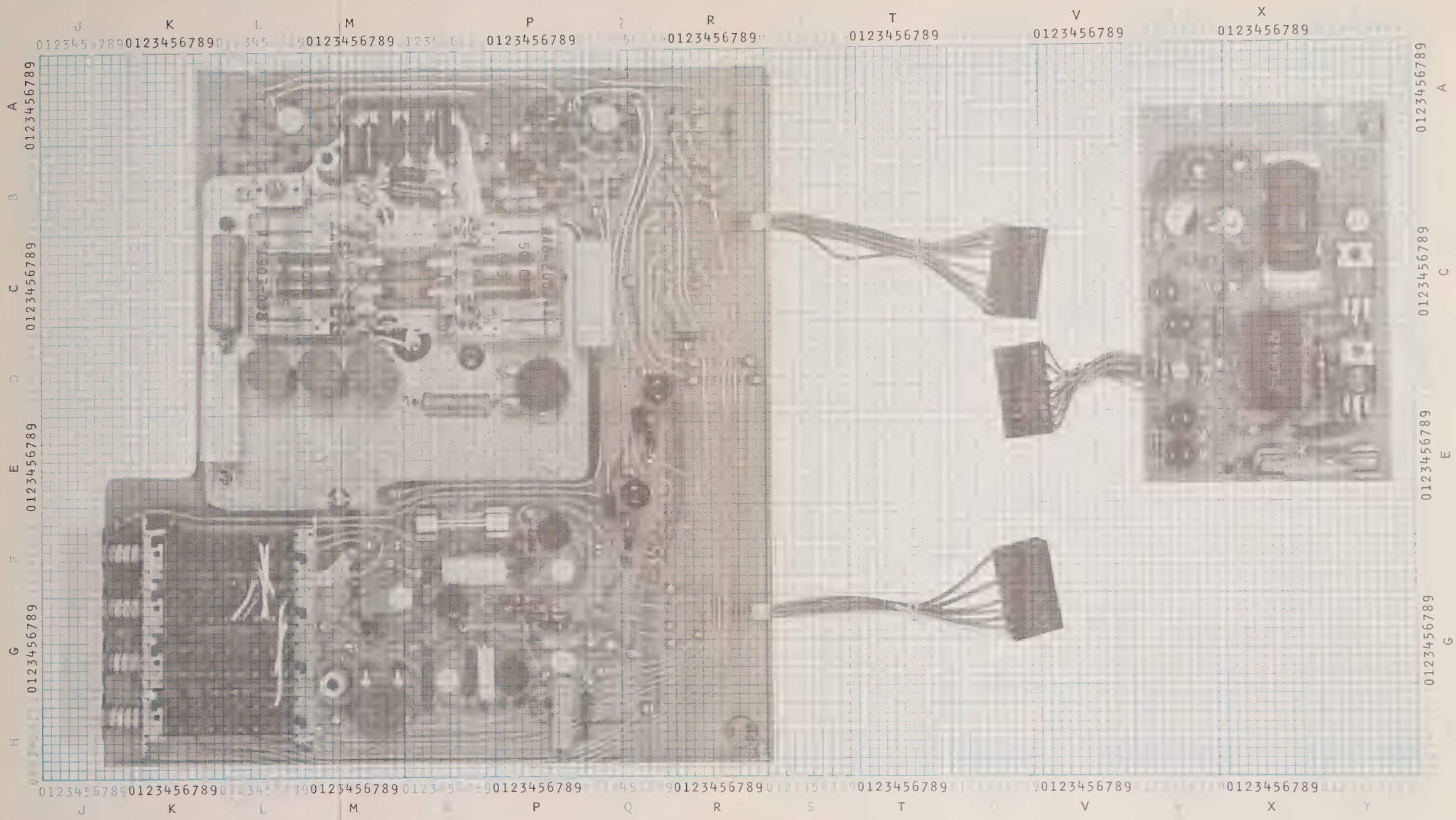


**Figure 5-2.** Function Switching Assembly with Battery Option Assembly

FUNCTION SWITCHING ASSEMBLY, P/N 35-24 (Figure 5-2)

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| A3L8 | A1 | LM301A | Amplifier | 12040 | 2 |
| A3Q3 | A2 | LM301A | Amplifier | 12040 | REF |
| B5L6 | C1 | 402 | Capacitor, 1.5 - 20 pF, 175V | 84171 | 1 |
| A2M8 | C2 | CM15C010D | Capacitor, 1 pF, 500V | 84171 | 2 |
| B7N1 | C3 | CM15C010D | Capacitor, 1 pF, 500V | 84171 | REF |
| A1N2 | C4 | CM15C100J | Capacitor, 10 pF, 500V | 84171 | 1 |
| B9P6 | C5 | DD300 | Capacitor, 30 pF, 1 KV | 71590 | 1 |
| A1N5 | C6 | CM15E201F | Capacitor, 200 pF, 500V | 84171 | 1 |
| A3L2 | C7 | JL150 | Capacitor, 150 pF, 1 KV | 91418 | 2 |
| A1P9 | C8 | JL150 | Capacitor, 150 pF, 1 KV | 91418 | REF |
| G1N9 | C9 | C281AB/A22K | Capacitor, 0.022 μF, 250V | 73445 | 1 |
| D1L0 | C10 | C281CG/A220K* | Capacitor, 0.22 μF, 630V | 73445 | 1 |
| F3N8 | C11 | C281CH/A470K | Capacitor, 0.47 μF, 100V | 73445 | 1 |
| C4Q2 | C12 | C281AB/B1M | Capacitor, 1 μF, 250V | 73445 | 1 |
| E0Q3 | C13 | TSD2-20-106 | Capacitor, 10 μF, 20V | 06751 | 2 |
| E9Q6 | C14 | TSD2-20-106 | Capacitor, 10 μF, 20V | 06751 | REF |
| B7P4 | C15 | TSD3-6-476 | Capacitor, 47 μF, 6V | 06751 | 1 |
| A0M5 | C18 | CM15C020D | Capacitor, 2 pF, 500V | 84171 | 1 |
| G7P5 | CR1 | 1N458 | Diode | 04713 | 4 |
| G7P7 | CR2 | 1N458 | Diode | 04713 | REF |
| G8P3 | CR3 | 1N458 | Diode | 04713 | REF |
| G9P2 | CR4 | 1N458 | Diode | 04713 | REF |
| B9L4 | CR5 | 1N914 | Diode | 07910 | 4 |
| B8L5 | CR6 | 1N914 | Diode | 07910 | REF |
| B6Q2 | CR7 | 1N914 | Diode | 07910 | REF |
| B5Q1 | CR8 | 1N914 | Diode | 07910 | REF |
| A1R3 | CR9 | 5003-002 | Diode | 03626 | 2 |
| A3R3 | CR10 | 5003-002 | Diode | 03626 | REF |
| F8N6 | F2 | 361.010 | Fuse, 8AG, 1/100A | 75915 | 1 |
| C5L9 | K1 | R40-E061-1 | Relay | 12300 | 2 |
| C5P2 | K2 | R40-E061-1 | Relay | 12300 | REF |
| F0U9 | P1 | 86148-1 | Connector | 00779 | 2 |
| C5U8 | P2 | 86148-1 | Connector | 00779 | REF |
| F7P7 | Q1 | TD101 | Transistor | 80183 | 1 |
| G1P2 | Q2 | TD401 | Transistor | 80183 | 2 |
| G9N5 | Q3 | TD401 | Transistor | 80183 | REF |
| D3Q9 | Q4 | 2N3569 | Transistor | 07263 | 1 |
| E1Q6 | Q5 | 2N3645 | Transistor | 07263 | 1 |
| G7M6 | Q6 | 2N3906 | Transistor | 04713 | 1 |
| A4P1 | R1 | U201R101B | Potentiometer, 100Ω | 11237 | 1 |
| H8M8 | R2 | U201R501B | Potentiometer, 500Ω | 11237 | 1 |
| D3P6 | R3 | U201R503B | Potentiometer, 50K | 11237 | 1 |
| H7P7 | R4 | 76P-R10K | Potentiometer, 10K | 80053 | 1 |
| G9K0 | R5 | 76P-R200K | Potentiometer, 200K (Reverse side) | 80053 | 2 |
| F5K0 | R6 | 76P-R200K | Potentiometer, 200K (Reverse side) | 80053 | REF |
| A1N6 | R7 | See Note 2 | Resistor, 2K (Matched) | | 1 |
| A1N3 | R8 | See Note 2 | Resistor, 20K (Matched) | | 1 |
| A1N0 | R9 | See Note 2 | Resistor, 200K (Matched) | | 1 |
| B3N1 | R10 | See Note 2 | Resistor, 1M (Matched) | | 1 |
| A0M7 | R11 | See Note 2 | Resistor, 1M (Matched) | | 1 |
| D5L5 | R12 | See Note 3 | Resistor, 10K (Matched) | | 1 |

*Alternate is C280CG/A220K

FUNCTION SWITCHING ASSEMBLY, P/N 35-24 (Figure 5-2) [Con't]

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| D5M1 | R13 | See Note 3 | Resistor, 90K (Matched) | | 1 |
| D5M7 | R14 | See Note 3 | Resistor, 900K (Matched) | | 1 |
| F4P3 | R15 | RC07GF151J | Resistor, 150Ω, 1/4W, 5% | | 1 |
| D9R2 | R16 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | 3 |
| F6Q5 | R17 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | REF |
| E8Q7 | R18 | RC07GF102J | Resistor, 1K, 1/4W, 5% | | REF |
| A3P7 | R19 | RC07GF104J | Resistor, 100K, 1/4W, 5% | | 1 |
| H8P4 | R20 | RC07GF244J | Resistor, 240K, 1/4W, 5% | | 1 |
| F5N9 | R21 | RC07GF624J | Resistor, 620K, 1/4W, 5% | | 1 |
| F0N2 | R22 | RC07GF205J | Resistor, 2M, 1/4W, 5% | | 3 |
| F1M5 | R23 | RC07GF205J | Resistor, 2M, 1/4W, 5% | | REF |
| F6P4 | R24 | RC07GF205J | Resistor, 2M, 1/4W, 5% | | REF |
| F1N3 | R25 | RC07GF395J | Resistor, 3.9M, 1/4W, 5% | | 1 |
| A0P8 | R26 | RC07GF106J | Resistor, 10M, 1/4W, 5% | | 2 |
| A2Q6 | R27 | RC07GF106J | Resistor, 10M, 1/4W, 5% | | REF |
| B6P4 | R30 | RN60C1102F | Resistor, 11K, 1/8W, 1% | | 1 |
| H7Q0 | R31 | RN60C5622F | Resistor, 56.2K, 1/8W, 1% | | 1 |
| G0N3 | R32 | RN60C9002F | Resistor, 90K, 1/8W, 1% | | 1 |
| G5P7 | R33 | RN60C1003F | Resistor, 100K, 1/8W, 1% | | 1 |
| B5P3 | R34 | RN60C2003F | Resistor, 200K, 1/8W, 1% | | 2 |
| B3P3 | R35 | RN60C2003F | Resistor, 200K, 1/8W, 1% | | REF |
| A2P5 | R36 | RN60E4991F | Resistor, 4.99K, 1/8W, 1% | | 1 |
| [illegible]N7 | R37 | RN60E1002F | Resistor, 10K, 1/8W, 1% | | 1 |
| [illegible]N[illegible] | R38 | PME 70T2 | Resistor, 8.981, 0.1% | 03888 | 1 |
| C5L1 | R39 | PME 75T9 | Resistor, 1M, 1W, 1% | 03888 | 1 |
| G6K2 | S1 | 35-39 | Switch Assembly | 03626 | 1 |

NOTES

(2) Resistors R7 thru R11 are a matched set and must be replaced as a matched set. Order by NLS part number 35-42.

(3) Resistors R12 thru R14 are a matched set and must be replaced as a matched set. Order by NLS part number 35-44.

BATTERY OPTION ASSEMBLY, P/N 35-47 (Figure 5-2)

| ZONE | REF DESIG | PART NO. | DESCRIPTION | MFG CODE | QTY PER ASSY |
|---|---|---|---|---|---|
| | BT1-BT5 | 7.0 SCL | Cell, "NICAD" (Not shown) | 03730 | 5 |
| E7Y0 | C1 | CK 503 | Capacitor, 0.05 μF, 50V | 71590 | 1 |
| C6X3 | C2 | TSD2-20-106 | Capacitor, 10 μF, 20V | 12406 | 1 |
| C8W8 | CR1 | 5003-002 | Diode | 03626 | 2 |
| D5X1 | CR2 | 5003-002 | Diode | 03626 | REF |
| B1W2 | CR3 | 1N4005/5CE6 | Diode | 04713 | 2 |
| B0W3 | CR4 | 1N4005/5CE6 | Diode | 04713 | REF |
| E4Y0 | F3 | 318.003 | Fuse, 3AG, 3A, Slo-Blo | 75915 | 1 |
| D5X5 | K1 | AZ530-13-2 | Relay, 6V | 26806 | 1 |
| D2U8 | P1 | 86148-1 | Connector | 00779 | 1 |
| C4Y4 | Q1 | TIP 32 | Transistor | 01295 | 2 |
| D3Y4 | Q2 | TIP 32 | Transistor | 01295 | REF |
| C3W4 | Q7 | 2N3569 | Transistor | 01295 | 2 |
| D9W5 | Q8 | 2N3569 | Transistor | 01295 | REF |
| E9W5 | Q9 | 2N3645 | Transistor | 01295 | 2 |
| E5W5 | Q10 | 2N3645 | Transistor | 01295 | REF |
| E6W3 | R9 | RC07GF152J | Resistor, 1.5K, 1/4W, 5% | | 1 |
| C6W8 | R10 | RC07GF512J | Resistor, 5.1K, 1/4W, 5% | | 1 |
| D5W7 | R11 | RC07GF752J | Resistor, 7.5K, 1/4W, 5% | | 1 |
| D6W3 | R12 | RC07GF103J | Resistor, 10K, 1/4W, 5% | | 1 |
| D4W4 | R13 | RC07GF473J | Resistor, 47K, 1/4W, 5% | | 2 |
| C5X1 | R14 | RC07GF473J | Resistor, 47K, 1/4W, 5% | | REF |
| D4Y0 | R15 | RC20GF150J | Resistor, 15Ω, 1/2W, 5% | | 1 |
| D9W9 | R16 | RC20GF121J | Resistor, 120Ω, 1/2W, 5% | | 1 |
| B1X7 | T1 | D302 | Transformer | 03626 | 1 |
| B6W8 | V1 | 1888 | Lamp | 71744 | 2 |
| B7X2 | V2 | 1888 | Lamp | 71744 | REF |

NOTE: With the Battery Option, Transformer D302 replaces Transformer D304 on the Main Board Assembly.

# CHAPTER VI

## RECOMMENDED SPARE PARTS LIST

| PART NO. | DESCRIPTION | QTY. |
|---|---|---|
| LM301A | Amplifier | 3 |
| ET102X010P01 | Capacitor | 2 |
| ET471X025A01 | Capacitor | 1 |
| TSD2-20-106 | Capacitor | 2 |
| 1N4005 | Diode | 4 |
| 1N458 | Diode | 2 |
| 1N5248B | Diode, Zener | 1 |
| 1N914 | Diode | 2 |
| 5003-002 | Diode | 2 |
| 5003-005 | Diode | 2 |
| 313.500 | Fuse | 2 |
| 361.010 | Fuse | 4 |
| N7441B | Integrated Circuit | 2 |
| SN15830N | Integrated Circuit | 1 |
| SN7400N | Integrated Circuit | 2 |
| SN7420N | Integrated Circuit | 1 |
| SN7473N | Integrated Circuit | 1 |
| SN7490N | Integrated Circuit | 2 |
| CM26-305 | Lamp, Indicator | 2 |
| 39-66 | Lamp, Indicator | 1 |
| 76P-R200K | Potentiometer | 1 |
| R40-E061-1 | Relay | 1 |
| PW162010001M | Resistor | 1 |
| PW162020001M | Resistor | 1 |
| PW162040600M | Resistor | 1 |
| PW162049500M | Resistor | 1 |
| 35-44 | Resistors -Matched Set | 1 |

| PART NO. | DESCRIPTION | QTY. |
|---|---|---|
| 35-43 | Resistor & Diode - Matched Set | 1 |
| TD101 | Transistor | 2 |
| TD401 | Transistor | 1 |
| TIP32 | Transistor | 1 |
| 2N3645 | Transistor | 3 |
| 2N3819 | Transistor | 1 |
| 2N3904 | Transistor | 4 |
| 2N3906 | Transistor | 3 |
| 2N4977 | Transistor | 1 |
| 5003-015 | Transistor | 1 |
| 40527 | Triac | 1 |
| ZM1000 | Tube, Indicator | 2 |
| | With Print Option - Add the Following | |
| 5003-002 | Diode | 2 |
| SN7400N | Integrated Circuit | 1 |
| 2N3569 | Transistor | 1 |
| | With Battery Option - Add the Following | |
| 7.0 SCL | Cell, "NICAD" | 5 |
| 1N4005 | Diode | 2 |
| 5003-002 | Diode | 1 |
| 1888 | Lamp | 2 |
| D303 | Transformer | 1 |
| TIP32 | Transistor | 2 |
| 2N3569 | Transistor | 1 |
| 2N3645 | Transistor | 1 |

# APPENDIX

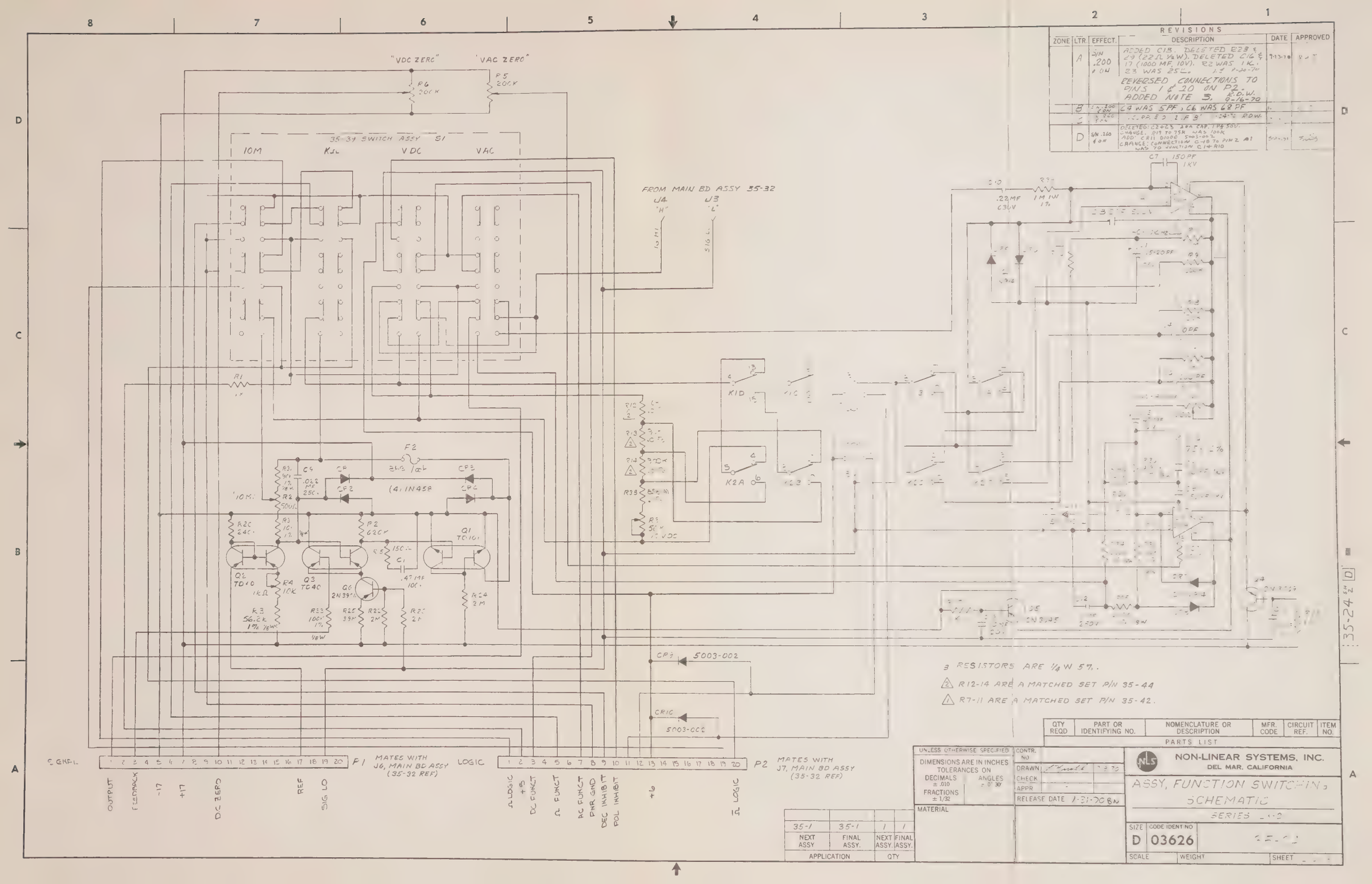
## SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvers. If the original shipping container is in good condition, it may be used.

## CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.


"VDC ZERO"
"VAC ZERO"
P6 200K
P5 200K
35-37 SWITCH ASSY S1
10M
K.Ω
VDC
VAC
FROM MAIN BD ASSY 35-32
J4 "H"
J3 "L"
SIG H
SIG L
R1 1M
F2 2AMP 3AB
(4) 1N458
CR1
CR2
CR3
C4 .022 MF 250V
R3 90K 1% 1/8W
R2 50K
10M.
R20 24K
R3 10K 1%
R4 10K
R5 150K
C1 .47 MF 100V
Q1 TO-10
Q2 TO-10
Q3 TO-10
Q4 2N3904
R23 100K 1%
R24 3.9K
R25 2M
R26 2M
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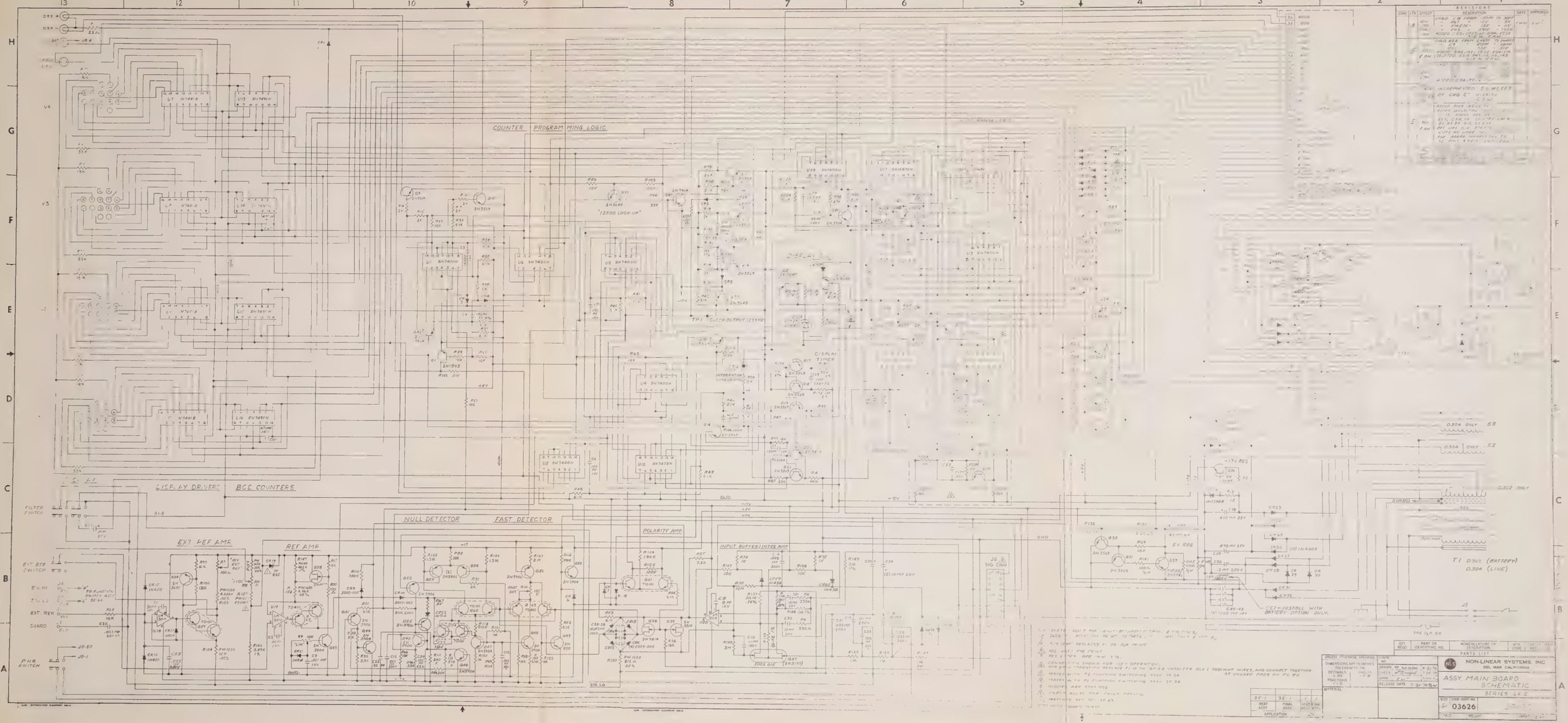
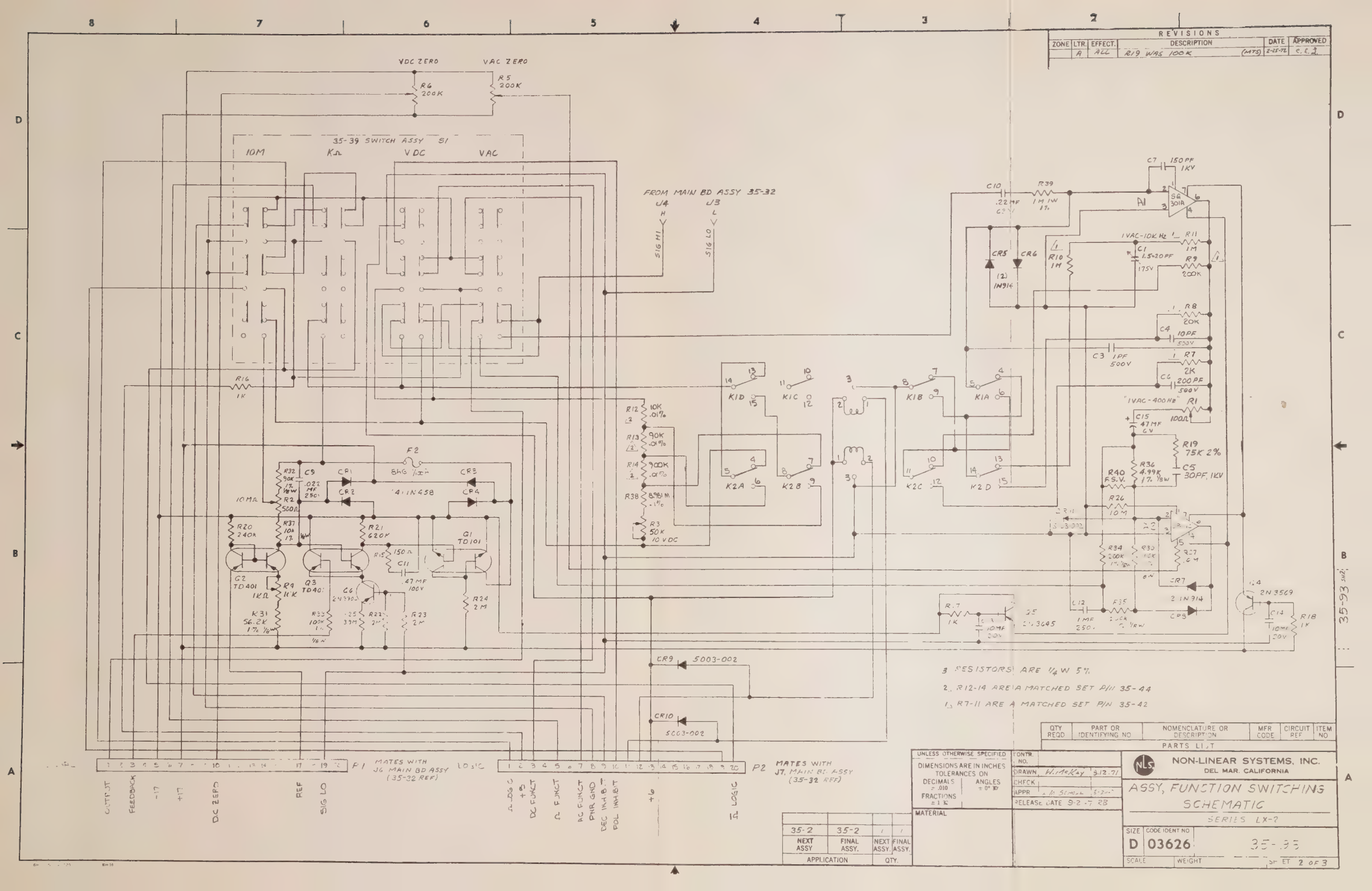

COUNTER PROGRAMMING LOGIC
DISPLAY DRIVERS
BCD COUNTERS
NULL DETECTOR
FAST DETECTOR
POLARITY AMP
INPUT BUFFER/INTEG AMP
EXT REF AMP
REF AMP
"12500 LOCK-UP"
CLOCK OUTPUT (125KHz)
INTEGRATOR
DISPLAY TIMER
5V REG
-17V REG
T1 D302 (RATIOED)
0.304 (LINE)
0.304 ONLY S3
0.304 ONLY S2
FILTER SWITCH
EXT REF SWITCH
EXT. REF.
GUARD
PNR SWITCH
SIG COMM
GND
+5V
-17V
+17V
TO FUNCTION SWITCH ASSY
"10V EXT. REF."
"1VDC"
"SLIN"
J5
J6
J8-30
J8-1




| REVISIONS | | | | | |
|---|---|---|---|---|---|
| ZONE | LTR. | EFFECT. | DESCRIPTION | DATE | APPROVED |
| | A | ALL | R19 WAS 100K (MTS) | 2-25-72 | C.E.J. |

3. RESISTORS ARE 1/4 W 5%

2. R12-14 ARE A MATCHED SET P/N 35-44

1. R7-11 ARE A MATCHED SET P/N 35-42

| QTY REQD | PART OR IDENTIFYING NO | NOMENCLATURE OR DESCRIPTION | MFR CODE | CIRCUIT REF | ITEM NO |
|---|---|---|---|---|---|

PARTS LIST

| | | | |
|---|---|---|---|
| 35-2 | 35-2 | / | / |
| NEXT ASSY | FINAL ASSY. | NEXT ASSY. | FINAL ASSY. |
| APPLICATION | | QTY. | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

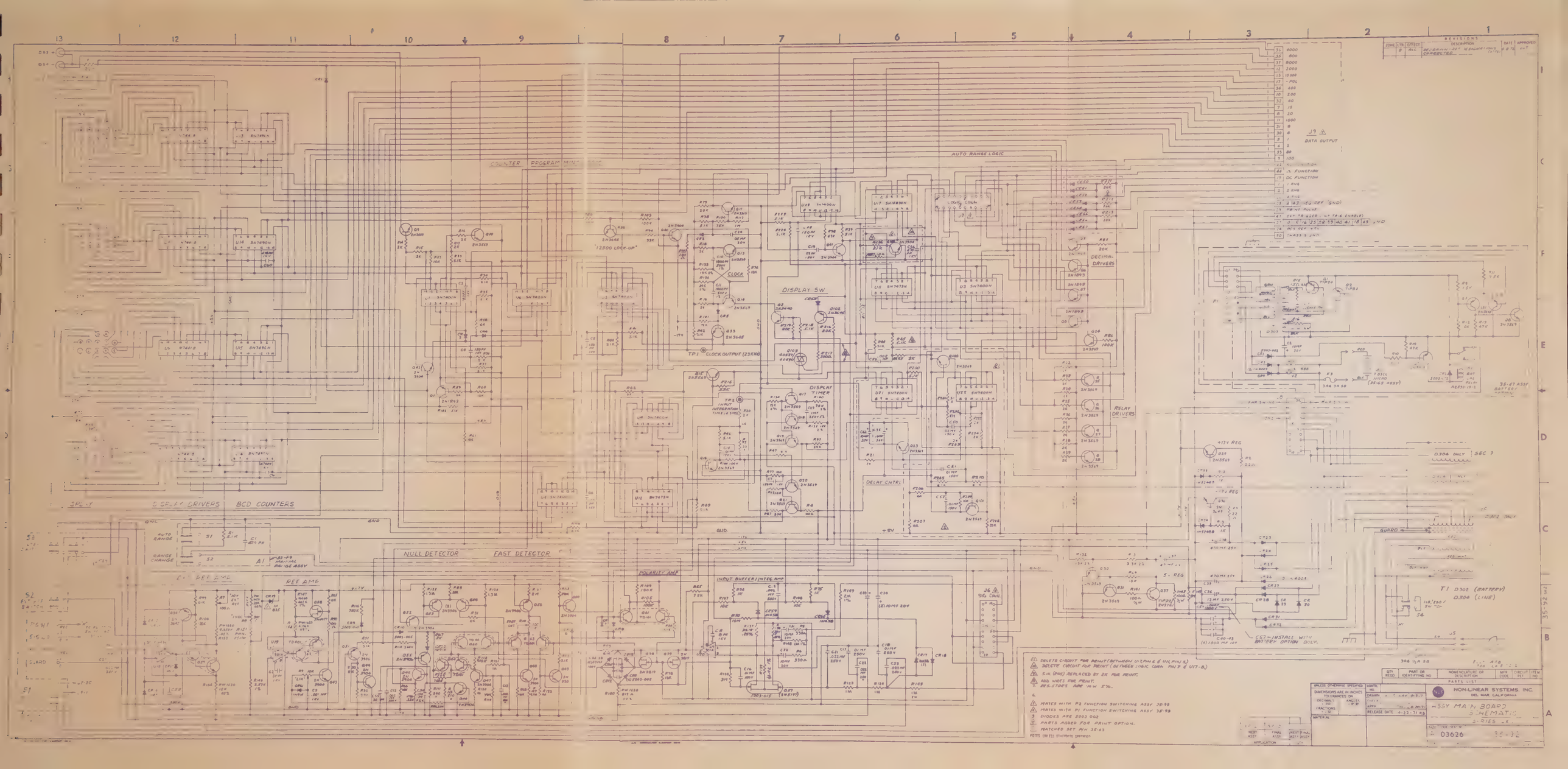
CONTR. NO.
DRAWN W. McKay 3.12.71
CHECK
APPR. 3-12-71
RELEASE DATE 9-2-7 RB

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

ASSY, FUNCTION SWITCHING SCHEMATIC
SERIES LX-?

| SIZE | CODE IDENT NO | |
|---|---|---|
| D | 03626 | 35-33 |
| SCALE | WEIGHT | SHEET 2 OF 3 |

35-93 SHT 2


COUNTER PROGRAMMING LOGIC
AUTO RANGE LOGIC
DISPLAY SW
DISPLAY TIMER
DELAY CNTRL
DECIMAL DRIVERS
RELAY DRIVERS
SPLY
SEGMENT DRIVERS
BCD COUNTERS
NULL DETECTOR
FAST DETECTOR
REF AMP
POLARITY AMP
INPUT BUFFER/INTEG AMP
CLOCK
"12500 LOCK-UP"
TP1 CLOCK OUTPUT (23KHz)
AUTO RANGE
RANGE CHANGE
A1 35-69 MANUAL RANGE ASSY
J9 DATA OUTPUT
J6 SIG COND
+17V REG
+5V REG
-5V REG
T1 D302 (BATTERY)
D304 (LINE)
0306 ONLY
SEC 7
DELETE CIRCUIT FOR PRINT (BETWEEN U17 PIN 6 & U15 PIN 2)
DELETE CIRCUIT FOR PRINT (BETWEEN LOGIC COMM PIN 9 & U17-8)
S.W. (ONE) REPLACED BY 2K FOR PRINT.
ADD WIRE FOR PRINT.
RES. STORS ARE 1KW 5%.
MATES WITH P2 FUNCTION SWITCHING ASSY 35-93
MATES WITH P1 FUNCTION SWITCHING ASSY 35-93
DIODES ARE 5003-003
PARTS ADDED FOR PRINT OPTION.
MATCHED SET P/N 35-63
NOTES UNLESS OTHERWISE SPECIFIED
C57=INSTALL WITH BATTERY OPTION ONLY.
REVISIONS
DESCRIPTION
DATE
APPROVED
ORIGINAL RELEASE
CORRECTED
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS
ANGLES
FRACTIONS
MATERIAL
DRAWN
RELEASE DATE 9-22-71 RB
NEXT ASSY
FINAL ASSY
APPLICATION
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA
ASSY MAIN BOARD
SCHEMATIC
SERIES K
SIZE
C
03626
35-92

# Warranty

It is the continuous effort of Non-Linear Systems, Inc., to design and manufacture its products in such fashion as to at all times achieve the maximum customer satisfaction. Non-Linear Systems, Inc., issues this warranty in full recognition of its continuing obligation to its customers and its desire to always retain their respect and good will.

Non-Linear Systems, Inc., shall correct, either by repair or replacement, defects in material or workmanship in Non-Linear manufactured units or components where such defect develops within one year after delivery of the equipment to the original customer. In the instance of a defect of Sub-assemblies, Assemblies or Instruments manufactured by others than Non-Linear, every effort will be made to assist the customer in obtaining relief from the original manufacturer.

Any instrument claimed to be defective must be returned to Non-Linear Systems, Inc., Del Mar, California, transportation charges prepaid. The instrument will be repaired and returned to the purchaser, transportation prepaid, unless the instrument is found to be damaged by misuse, in which case the instrument will be returned to the purchaser with repair and transportation billed.

This warranty, being the entire agreement between the parties, is given expressly and in place of all other express or implied warranties including implied warranties for merchantability or fitness for particular use.

Non-Linear Systems, Inc.

# SHIPPING NOTICE / PACKING SLIP

NOTE: This completed form must accompany shipment.

Date _____

Date of Original Purchase: ___/___ (Mo. / Yr.)  Your Original P.O. No. _____

CUSTOMER SHIP PRE-PAID TO:

**NON-LINEAR SYSTEMS, INC.**
**533 STEVENS AVE.**
**SOLANA BEACH, CALIFORNIA 92075**

NLS RETURN(FREIGHT PAID)TO:

_____

_____

_____

Attn: _____

When using window envelope, fold here.

Description of Instrument and Accessories Included:

Instrument Model No. _____ P/N _____ S/N _____

Accessories _____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

Reason for Return (specify malfunctions in detail):

_____

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NLS Form 200-50

# SHIPPING NOTICE / PACKING SLIP

NOTE: This completed form must accompany shipment.

Date _____

Date of Original Purchase: ___/___ (Mo./Yr.)  Your Original P.O. No. _____

CUSTOMER SHIP PRE-PAID TO:

**NON-LINEAR SYSTEMS, INC.**
**533 STEVENS AVE.**
**SOLANA BEACH, CALIFORNIA 92075**

NLS RETURN(FREIGHT PAID)TO:

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Attn: _____

When using window envelope, fold here.

Description of Instrument and Accessories Included:

Instrument Model No. _____ P/N _____ S/N _____

Accessories _____ P/N _____ S/N _____

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_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

_____ P/N _____ S/N _____

Reason for Return (specify malfunctions in detail):

_____

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NLS Form 200-50

## NOTICE

If at any time it should become necessary to return an NLS instrument to the factory, follow the instructions contained in the Appendix of this manual (page A-1) and utilize NLS Form No. 200-50 (Shipping Notice/Packing Slip), located at the rear of the manual.

www.manualsplus.com
1022468